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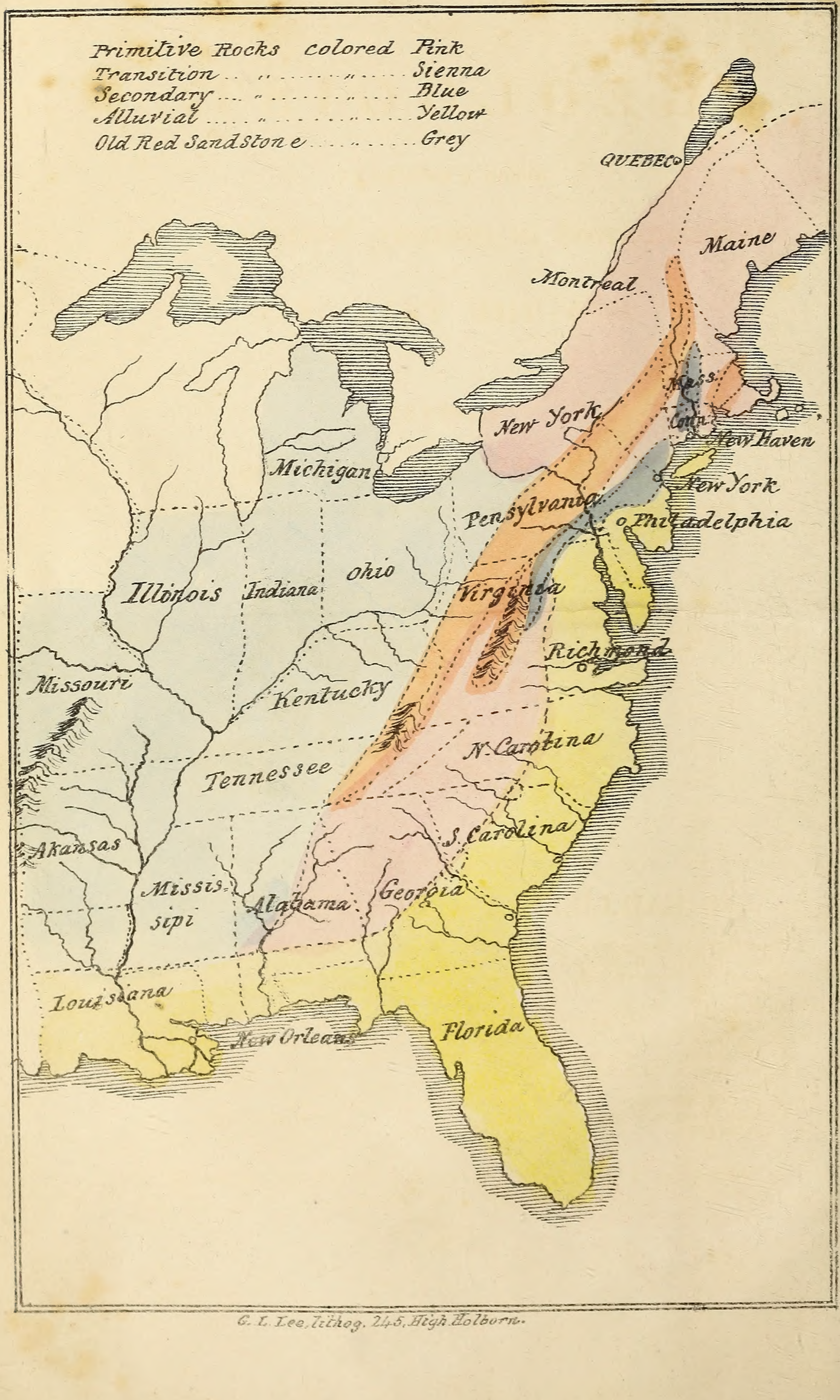

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THE

GEOLOGIST,

BEING A RECORD OF

INVESTIGATIONS IN GEOLOGY, MINERALOGY, &c.,

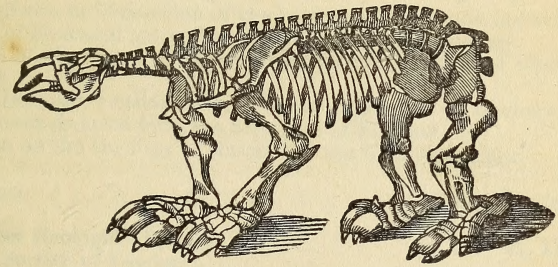
FOR THE YEAR 1843,

Nos. 13–18

EDITED BY

CHARLES MOXON, Esq.,

HON. CURATOR (LATE TREASURER) OF THE SCIENTIFIC SOCIETY OF LONDON.



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BRITISH MUSEUM NATURAL HISTORY

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SKETCH

OF THE

PROGRESS OF GEOLOGY, &c., IN 1843.

The close of the year 1843 brings with it the duty of a review of the past, as the means of instituting the comparison between the condition of the science of Geology at the commencement and its state at the close; to elicit what has been done by the individual labours of so many untired naturalists, and the joint efforts of so many societies as are now devoted to the cultivation of this particular department of science.

We are sorry that we cannot give them, either the one or the other, any flattering proofs of their having arrived nearer the desideratum to be gained; we have, to be sure, had a printed record of many investigations which had been conducted during the preceding year, but these came not with the air of novelty, or with so much interest as they would have done a twelvemonth since, when these particular subjects were quite unexplored, or unknown to geologists in this part of the world. We hear that much is going on in the way of generalization, but as yet we have heard of no results; we hear of geologists being occupied in researches of great interest but there are no tidings of their fulfilment. Whence this apathy? whence this seeming neglect? rendering, as has been the case, the year 1843 one of but mimic enthusiasm. However, we will not dwell too long on *regrets*; and leaving this portion (having fulfilled our duty in thus briefly expressing our opinion) we will endeavour to collate from the matter that has been presented to our notice, so much of interest as shall encourage to greater and more largely rewarded exertion—may be, the apparent apathy is in part attributable, in this instance, to the various political and commercial disturbances which have withdrawn the attention and taken away the means from such pursuits and their due publication.

Of the results of individual exertion we cannot give the sum total as the records of these are widely distributed, and no settled mode for their collection has been adopted; we trust, however, that as our journal progresses, so it will fall into the hands of all active geologists, and they may be led to record in our pages what they do not contribute to societies, the reports of which find their way into our work as a matter of course; we refer to the reports of *Geological* (not merely local) Societies. Of the value of preserving such collateral records, we would instance a simple case which is to be found in our present volume.

For example, the circumstances under which "Lignite" occurs —as tending to elucidate not only the age of the deposit in which it is buried, but the comparative preservative powers of the several beds—of this we have recorded both Mr. Green's and Mr. Rose's researches, singularly enough relating to neighbouring, if not identical deposits; then again, the researches relative to American geology are thus placed side by side, affording considerable elucidation of the subject; but on this we shall dwell more largely at some future portion of our summary. In placing before our readers the annual summary we hope then to effect two objects, viz. to inform them of what has been done in geology since we were last occupied in the same manner, and to prove that we have effected our purpose also.

The Glacial Theory.—This, so lately, all important question, has elicited but little interest during the past year, although its agency to a limited extent is fully acknowledged. Investigation has turned, from the consideration of the theory, to the observance of such facts as will suport the views of geologists on the subject of the transportation of erratic blocks—their distribution, and their origin. An interesting essay, on a subject closely connected with this, was read at the 1842 meeting of the Association of American Geologists, and amongst the facts therein recorded of the nature of icebergs, as seen in their progress southward, both near the shore and in the middle of the ocean, was this, that large masses of rock and quantities of earthy matter were imbedded in the sides of the icebergs in question, the water for at least a quarter of a mile round them being full of mud, stirred up from the bottom and the sides of the mass.—(Vol. II. p. 35.) The general description here made use of applies to all instances, individually—the inference drawn from these facts, and which is given in the paper alluded to, is, in our opinion, a practical exposition of the circumstances under which these erratic blocks were and are deposited. The general rules of their *disposition,* will only be better understood when the general problem of periodical tides is more completely solved.

In immediate connection with this elucidation, we would place the conclusion at which Prof. H. D. Rogers has arrived during his surveys of the Appalachian Chain, viz:—that the striæ and furrows observed on the summit of most of the rocks in that locality are connected with the question of *drift,* not of *glacial* action. This adds other most important evidence of the general effects of *diluvio-glacial force.*

This grand question then, resolves itself into the following divisions.

Diluvio-glacial action, including

- The disposition of Erratic blocks,
- The disposition of moraines,
- The phenomena of raised beaches,
- Detrital phenomena in general,

all of them relating purely to the tertiary epoch of geological change. The conclusion thus arrived at, proves "that no one cause could have been adequate to the formation of *all* the varieties of superficial detritus."

It is not our purpose to say all that has been done in each of these divisions—the "opinion" is all that we can grapple with in the allotted space, and we can only put it upon record that each of these several questions bears reciprocal relationships to the others, as portions of the grand theory.

Amongst the essays we have published in the present volume we would refer to

1. Prof. Hitchcock's on the Phenomena of Drift in the Uni-States, p. 34.
2. Mr. Couthoy on Icebergs, p. 35.
3. Prof. H. D. Rogers on Striated Surfaces in Pensylvania, &c. p. 40.
4. M. Daubree on the Erratic Phenomena and Diluvium of Sweden and Norway, p. 41.
5. Mr. Binney on the Lancashire and Cheshire Drift, p. 112.
6. Mr. Harkness on the Glacial Theory, p. 122.
7. Mr. Lyell on the elevated Beaches and Boulder Formations of the Canadian Lakes, p. 130.

On the Formation of Coal.—The extension of observation on this subject, both in the European and American continents, has led to the establishment of the diverse views of various geologists on this important question. Mr. Logan in Pensylvania, and subsequently in Wales, has turned his attention to the accompanying phenomena observable in both countries, and connected with both purely carbonaceous and anthracitic coal. Mr. Rogers in other parts of the United States has been engaged in similar investigations; and Mr. Binney in our own country, has turned his attention to the same question; and for which he has such ample opportunities in his proximity to our Lancashire Coal-fields.

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* Mr. Murchison's Geological Address, 1843, p. 92.

The result has been that two favorite theories have been adjudged to be, each of them, perfectly consistent with facts : viz. that which founded the origin of Coal measures, on the destruction of plants *in situ*—and in other instances, especially where the testaceous remains are more abundant than under circumstances to which the foregoing origin is applicable—from the drifting of large quantities of vegetable matter into estuaries and shallows. Of the comparitive age of each, no further proof is wanting, when each of the above mentioned labourers in this interesting field of enquiry, reports, that the fireclay with *Stigmaria ficoides* underlies every formation which they have examined.

This question involved many points of perplexity—and the result could hardly have been otherwise. It was impossible that two formations, deposited by precisely the same agency, should—one of them—present a most complete overthrow of all vegetation; trees torn up and buried promiscuously with remains of myriads of the finny tribes—the other—covering large trunks yet standing erect, although overwhelmed; the reasoning is made yet more clear upon a comprehensive view of Mr. Binney's labours—the *Cypris* of which mention was made in his first essay on the subject of the Manchester Coal-field*, appears to be both a marine and fresh-water production : it is clear that the associated fish partake of both characters, that is to say, different individuals were of distinct habits—and these reasons, coupled with the manner of their occurence, indicate pretty distinctly the circumstances of the deposit also.

An irruption of salt water into a fresh-water estuary would cause destruction to both fish alike, and hence the associated remains of these two distinct classes in the same formation. As connected with this subject, may be classed those researches which relate to modern vegetable deposits, as indicative of their mode of formation under different circumstances; we forbear to draw any inferences as yet, but, as in the preceding case, we annex a list of the essays published in this present volume bearing up on this question.

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* Geologist. vol. i. p. 59.

1. Green on the Lignite of Bacton, p. 12.
2. Binney on the fossil fishes of the Manchester coal-field, p. 15.
3. Prof. Rogers on the age of the Coal Rocks of Eastern Virginia, p. 38.
4. M. Mandre onthe peat formation of the Moselle, p. 45.
5. Dr. Black on the submerged forests of Great Britain, p. 174.

American Geology.—Various causes have led to the growing interest on this subject; the memoirs of Professor Rogers and Mr. Logan, already alluded to—the publication of official reports on the geology of several of the states—the recent visit of Mr. Lyell to those shores, all these have raised the subject into more than comparitive importance, and the record of the past two years indicates a considerable progress in our knowledge. The appalachian chain, the object of investigation of the Messrs. Rogers, is composed of palæozoic deposits conformable to each other, and which have been identified with Silurian, Devonian and Carboniferous deposits.*

Extending from north-east to south-west, the older rocks of the Appalachian chain (the total length of which is 1200 miles, with an average width of 100 miles,) have been thrown into a number of anticlinal ridges, and synclinal vallies from 100 to 150 miles in length, and all more or less parallel to each other, but with certain deviations from rectilinear to curved directions; describing many of these, the Professors Rogers show, that as the folds approach to the south-east, where igneous and crystalline rocks occur, convolutions are much more rapid, accompanied by many brakes and by complete invasions of the beds. This latter phenomena is identified with that which has been recognized on the flanks of the Alps and other eruptive continental chains, where the older strata are incumbent on younger, and on the western flanks of our own little Malvern Hills, where there is, as before stated, a complete illustration of inverted dip. Seeing also, that in proportion as they recede from the main axis the folds are less abrupt, and gradually open out into broad and flattened anticlinals, which entirely die away at a certain distance from the crystalline and intrusive rocks, or towards the interior, the authors form a theory which they conceive to be applicable to the bending and elevation of strata generally.

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* Vide Murchison's address 1843. p. 118.

Comparing the undulations which mark the axes with the undulatory motion of the earth during earthquakes, they beleive that all the grand ancient flexures of South America were produced at one time, and at the termination of the carboniferous era, up to which period they were all beneath the sea, and consequently still in a flexible condition. These sediments were it is supposed subjected to flexures by the invasion from below of another matter; and the peculiar and numerous convolutions are explained by calling into play an upheaving wave-like oscillation, accompanied by a tangential or lateral pressure upon flexible masses which reposed upon a semifluid matter.

Dr. Dale Owen, has been engaged on the geology of Indiana and the Western States. The result informs us that the district between 35° and 43° N. lat. and 81° and 91° W. lon., including the slates of Illinois, Indiana, Ohio, Kentucky, and Tenessee,) is composed chiefly of the carboniferous and silurian systems.*

Mr. Lyell, has thrown much light upon the tertiary strata of the United States, from Virginia northwards and southwards on the sea coast line, and which has been fully reported in the Geologist, vol. I. p. 213. and vol. 2. p. 160. The result as already communicated to our readers, is his opinion, that the tertiary

* Geologist. vol. i. p. 251.

formations which he examined agree well in zoological types with the eocene and miocene beds of England and France; that he found no secondary fossils in those rocks which have been called upper secondary, but that all the organic remains of the intermediate beds are characteristic of lower tertiary beds.

With this brief remark we will take our leave of the subject, leaving such of our readers as are interested in any of the more minute details to be deduced from the subjects under consideration, to refer to the essays themselves of which we have published copious reports in these and preceding pages.

THE EDITOR.

THE GEOLOGIST,

A MONTHLY RECORD OF INVESTIGATIONS AND DISCOVERIES IN GEOLOGY, MINERALOGY AND THEIR ASSOCIATE SCIENCES.

On the Geology of Central Cheshire. By G. W. Ormerod, Esq., F.G.S.

The part of Cheshire to which this sketch relate is the district lying between the northern edge of the map given in Murchison's Silurian System, and the southern extremity of the Lancashire coal-field, bounded on the west by the level extending in a southerly direction from Frodsham, by Dunham on the Hill towards Cheshire, and on the east by the high land reaching from Stockport by Marple and Macclesfield to Bosley, and thence along the range of hills separating Cheshire from Staffordshire. * * * The *keuper* and the bunter-sandstein occupy almost entirely that part of Cheshire about to be noticed. The *keuper* in Cheshire separates itself into four natural divisions; the supra-gypseous, the gypseous or saliferous, the infra-gypseous, the water-stone. The bunter-sandstein varies so greatly in character, even within very short distances, that he had not as yet been able to class the beds satisfactorily; it was therefore treated as one mass. The county of Cheshire was then stated to be divided into two parts by a fault commencing at a dislocation or anticlinal line, found at the Peckforton hills. These hills are composed of bunter-sandstein, having the saliferous district of Nantwich, Combermere, and Dirtwich on the S. E., and that of Aldersey on the N.W. Proceeding in a north-easterly direction from Nantwich, a gently undulating, but deep sandy district is passed over, containing the salt-field of Middlewich, Weaver Hall and Winsford. The N.W. boundary is continued from the Peckforton hills by the insulated rock of Beeston Castle, dipping E.N.E. 12°. The boundary is again carried on by the rising ground which recommences on the N. of Beeston Brook, between Tarporley and Four Lane Ends, near a brook, between which places the rock dips S.E. by S. 7°, and thence continues by Portal Lodge to the brook by Luddington Hill. From Tarporley to this last place, the road is taken along the range of the strata. Sand and gravel from thence cover the country. A fault separates the salt districts of Winsford and Northwich. This extends along the course of the Weaver from Vale Royal to the E. of Northwich by Leftwich. Between the two districts just mentioned, salt-springs rise near Eaton and Hartford, thrown up, most probably, by the fault. A sinking was made near the last-mentioned spring to a depth of 80 yards, and brine was not found. The salt at Northwich lies at a depth of 45 yards; at Wharton, on the western part of the Winsford district, at a depth of 50 yards. At Hartford Clough and at Leftwich, attempts were made to reach the brine; but were abandoned on account of the great depth of sand and gravel. From this point, deep drift covers the country to Mere, but borings, sufficient to supply exact information, have not been made. Those, however, made at Wincham, on comparison with the Northwich sinkings, seem to indicate that a dislocation exists between those two places. The borings of Wincham were as follow:—Soil and marl nine yards, plaister and marl fifty yards, rock salt two or three inches, marl and plaister forty yards, when the common red marl was reached, and the boring was not continued. A fault must also occur between Knutsford and Mere; gypseous beds being found at Mobberly, near the first place, and near the latter the water-stone beds; these last dipping to the south, and so situated, that, if continued on the range, they would occupy the place of the gypseous beds. A little more to the north by the Bollin, near Bank House, is a sudden rise in the ground;

and the higher beds of the water-stone are seen dipping W.S.W. by W. from 8° to 10°. More northerly, at Brownlow Hill, the water-stone dips W.S.W. 10°, and is but a short distance from the bunter-sandstein, which lies to the W. at Timperley, where it dips S. by W. 4°: between these places at Clay Hall, very possibly occupying the fault, red marls and gypsum are found: beyond this point he had not been able to trace this fault.

Commencing on the S.E. side of the Peckforton fault, the lias, as mentioned by Murchison in his "Silurian System, is found at Audlem. The salt measures appear from under it; occupying the country to a line drawn from Madeley to Beeston Castle as a general boundary. After this point the deep sand or drift occurs, which at Coppenhall is 70 feet thick, and teeth and bones were found in it; one of the teeth was three inches long. The salt next appears at Weaver Hall, and extends thence along the Weaver, to near Vale Royal. This salt is identical with that found at Northwich: at both places the rock salt is found. The field of salt extends in an easterly direction to Middlewich, where the brine is worked, and from there can be traced, by borings and gypseous marls, along the Dane to Congleton, and along the Wheelock to Lawton. Thence up to Bosley, the range of Mow Cop and Cloud Hills extends. These are of limestone, millstone grit and coal; and extend in a more southerly direction towards Madeley. The infra-gypseous and water-stone beds lie between Congleton and Crossledge Hall. Extending along the same side of the Peckforton fault, water-stone is found by the Peover viaduct. The next rock is Alderley Edge. This range is of bunter-sandstein. The beds vary greatly in character; copper, lead and cobalt are found there. The dip varies from W.N.W. to W.S.W. and from 10° to 18°. Alderley Edge forms part of a long insulated range of high ground, surrounded by drift, probably continuing to the N.W., as beds of bunter-sandstein of the same character are seen near Styall, at Quarry Bank, and in the course of the Bollin. The last beds dip 48° a little to the N. of W., abutting against the lower beds of water-stone, there dipping 7° a little to the W. of S. From Quarry Bank water-stone occupies the Bollin to Ashley, and is again found at Brownlow Mill. The bunter-sandstein, more northerly, is found at Barlow Hall, and extends thence by Cheadle and Stockport to Poynton, where it overlies the coal. Returning to Barlow Hall, it is seen in the brook near Hough's End, and extends to Chorlton-on-Medlock, where it is described by Mr. Binney in his paper on the geology of this neighbourhood.

Crossing to the northern side of the Peckforton fault, the identity of the Northwich and the Winsford salt was first shown. The depth to the upper salt at Northwich is 135 feet; at Wharton (the place where the rock salt of Winsford district is worked), the depth is 150 feet. At Northwich, the thickness of the upper bed is from 75 to 90 feet; at Wharton, 120 feet. At *both places* this bed is impure. The thickness of the bed between this mine and the second salt is, at Nortwich, 30 feet; at Wharton, 36 feet. This stratum at both places is composed of indurated marl, with gypsum and veins of salt traversing it. At both places the next stratum is the thick bed of salt. This has been now penetrated at Northwich, and found to be from 96 to upwards of 117 feet in thickness. The upper part at Northwich, for a thickness of from 69 to 75 feet, is not worked, being impure; and only the 12 or 15 feet underlying that portion are got. At Wharton, the highest 75 feet of the second salt are not worked; but only the 15 feet below that depth. Along the Weaver to near Frodsham, brine springs and gypseous beds are found in various places, on both sides of the Weaver. The strata are, however, much broken. Thus, at a small brook by the side of the Weston canal, about 200 yards from the swing bridge, is a dislocation, at which the beds there apparently water-stone, dip E. by S. 80°. On the S. side of the Weaver, at the first hill on the Frodsham road, are contorted beds of clayey stone, forming a saddle ranging from N.N.W. to S.S.E. and dipping on the northerly side E. by S. 3°. These strata resemble the beds seen at Preston Hill and Town, there overlying the water-stone, and forming the infra-gypseous beds. The beds just mentioned as occurring on the S. side of the Weaver were penetrated to a depth of 475 feet, at the salt works west of Frodsham Bridges, now held by Mr. Pickering, and to whose kindness I am indebted for a copy of the borings. A weak brine was found at the depth of 288 feet 10 inches. No rock salt was detected. The measures consisted chiefly of hard and gritty beds. A shaft was sunk at the above works near the side of the river, to the depth of 30 yards, and then abandoned. These measures in the upper beds contained a little spar; but they were generally gritty, with bands of a ferruginous nature, very hard; so much so, as to require blasting. The salt manufactured here is made from the salt water of the Mersey, strengthened by rock salt brought from Northwich. To the N. of the Weaver, the infra-gypseous water-stone and bunter-sandstein beds occur, occupying a range extending from Grappenhall to Mere. A fine section of the whole series of beds is given by descending Bradley Brook. Impressions of the footstsps of the *Labyrinthodon platypus* are found in the lowest beds of the water-stone at Lymm. Between Lymm and Warburton, a fault of about 400 yards exists. Water-stone is again found at Warburton, very much broken. Salt-springs are found at Dunham, Mill Bank and Woolden. The country between this line and Altrincham, by Carrington Moss, has not yet been examined. To the west of the river Weaver successive ranges of water-stone and bunter-sandstein extend from Hill Cliff to Runcorn,—the result of a series of dislocations causing the recurrence of the same beds three times in that distance. The part of the bunter-sandstein between Halton and Runcorn point is so much broken as to render a minute description impossible within our limited space. Between Runcorn and Higher Runcorn, buried under the drift, is a fault, separating that range of hills from the one just described. A small synclinal axis runs between Weston and Rock Savage. To the S. of the trough of the Weaver, lies the great range of the hills of Delamere Forest. These consist chiefly of bunter-sandstein. Water-stone is found near Kelsall and near Utkinton. It is impossible here, however, to enter into a detailed description of the forest. To the south of the forest range, lies the extensive flat containing the salt measures of Aldersey. The thickness of the salt-measures, computed from borings at Wincham, Northwich, and the upper part of the Frodsham borings, was stated to be more than 354 yards. The thickness of the infra-gypseous beds along Bradley Brook, was stated to be upwards of 80 yards; and that of the water-stone beds along the same brook 100 yards. The thickness of the bunter-sandstein beds could not be estimated; but at Hill Cliff it is more than 350 feet. Two faults were shown to extend from S.W. to N.E.; one, along the eastern boundary of the county by Mow and Cloud, and the other the great Peckforton fault. Two others ranged from N.W. to S.E.; one extending from Madely to the N. of Nantwich, between Beeston and Tarporley, and thence skirting the high ground by the S. of Delamere Forest. The second was formed by the trough of the Weaver at Northwich. A fault was shown to range from E. to W. running partly along the Mersey between Lymm and Warburton, below Altrincham, and between Timperley and Barlow Hall. Of none of these dislocations had the extremities as yet been determined.—*Transactions of Manchester Geol. Soc.*

Ehrenberg's Notices of American Infusoria.

On the 25th of March, 1841, M. Ehrenberg made a communication to the Royal Academy at Berlin, in which he referred to specimens of American fossil infusoria sent for his examination by Professors Silliman, Bailey and Hitchcock. The chief results of his examinations of American species are:

1. In North and South America there occur not only living but fossil microscopic organisms, forming strata geologically important, and very similar in their relations to the European.

2. The American forms are for the most part similar to the European.

3. One hundred and forty-three species are common to Europe, and seventy-one (or one third), peculiar to America.

4. Not one of the American infusorial deposits resembles in its elementary forms the chalk marl of the south of Europe. Nevertheless, there is found in the deposit near Spencer, Mass., the *Rotalia globulosa,* which is decidedly peculiar to the writing chalk*.

5. Most of the fossil deposits of North America are found in peat bogs, and contain forms of infusoria clearly referable to the brackish freshwater forms of the sea-coast, although some of them are at a distance from the sea.

6. Catalogues of the American infusoria determined by Ehrenberg.

---

* This statement was made before Prof. Ehrenberg was aware of the discovery made by Prof. W. B. Rogers, of the tertiary infusorial strata in Virginia. I have shown these strata to agree with those of Oran, &c., in containing immense numbers of the same species of Actinocyclus, Coscinodiscus, Dictyocha, &c., which characterize the chalk marls of Oran, Caltisanetta, &c. Some of these species I have seen still living in our waters, not only on the sea-shore, as at Boston harbour, but also sixty miles up the Hudson river.

The occurrence of the marine Rotalia globulosa, in the infusorial deposit of Spencer, an inland town of Massachusetts, would lead to curious inferences were the fact well established; but having repeatedly examined specimens from that locality, and never having seen in them any but fluviatile organisms, I am inclined to think that a portion of chalk may have been accidentally mixed with Ehrenberg's specimens.—*Note of the Editors of the American Journal of Science.*

Some of the most common fossil species have been found still living so far west as Ouisconsin river.

Fossil.

Amphiphora navicularis,
Cocconema Arcus.
,, lunula.
Eunotia amphioxus.
,, biceps.
,, bidens.
,, Monodon.
,, prærupta.
,, uncinata.
,, zebrina.
Fragillaria constructa.
,, piunata.
,, paradoxa.
Gomphonema Americana.
,, lanceolatum.
,, nasutum.
,, undulatum.
Himantidum gracile.
Navicula Americana.
,, amphigomphus.
,, amphioxys.
,, Bacterium.
,, Baileyii.

Navicula costata.
,, decora.
,, dilatata.
,, gastrum.
,, grammatostoma.
,, Hitchcockii.
,, legumen.
,, oblonga.
,, porrecta.
,, pumilis.
,, silicata.
,, Sillimanorum.
,, tumidula.
Staurosira construens.
,, pinnata.
Tabellaria amphilepta.
,, nodosa.
,, biceps.
Spongia ramosa.
,, serpentina.
,, setosa.
Thylacium ossiculum.
,, semiorbiculare.

Recent.

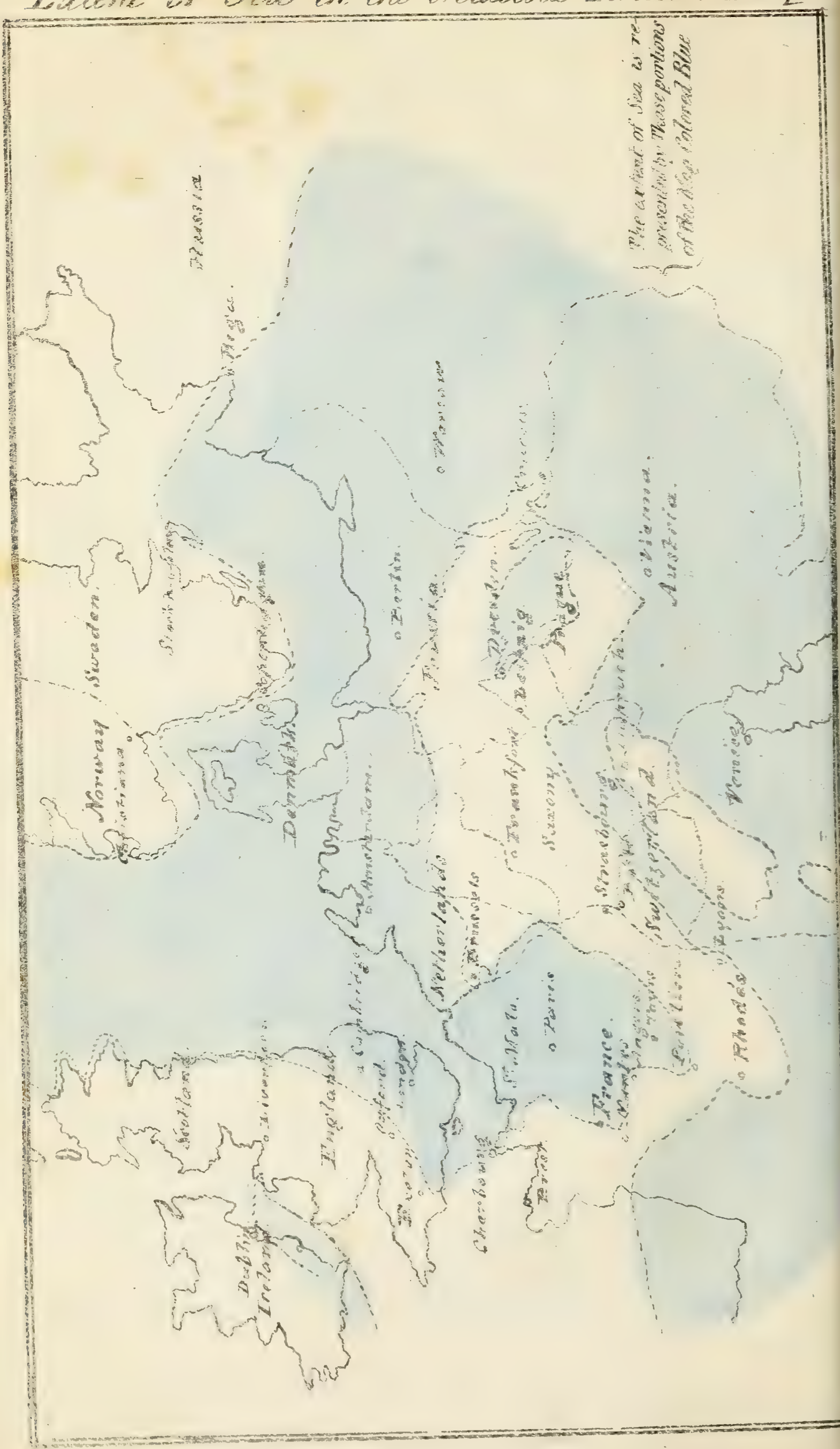
Achnanthes pactrypus.
Actinocyclus hexapterus.
Cocconeis oceanica.
Dictyocha panduriformis.
,, splendens.
Echinella monoligera.
Fragillaria catena.
,, pinnata.
Gomphonema subtile.

Navicula læta.
,, retieulata.
Podosira moniliformis.
Spongia capitata.
,, clara.
,, Neptuni.
,, obtusa.
,, uncinata.
Globulus porosus.

BRITISH MUSEUM
NATURAL HISTORY

PLATE I. Fig. 1.

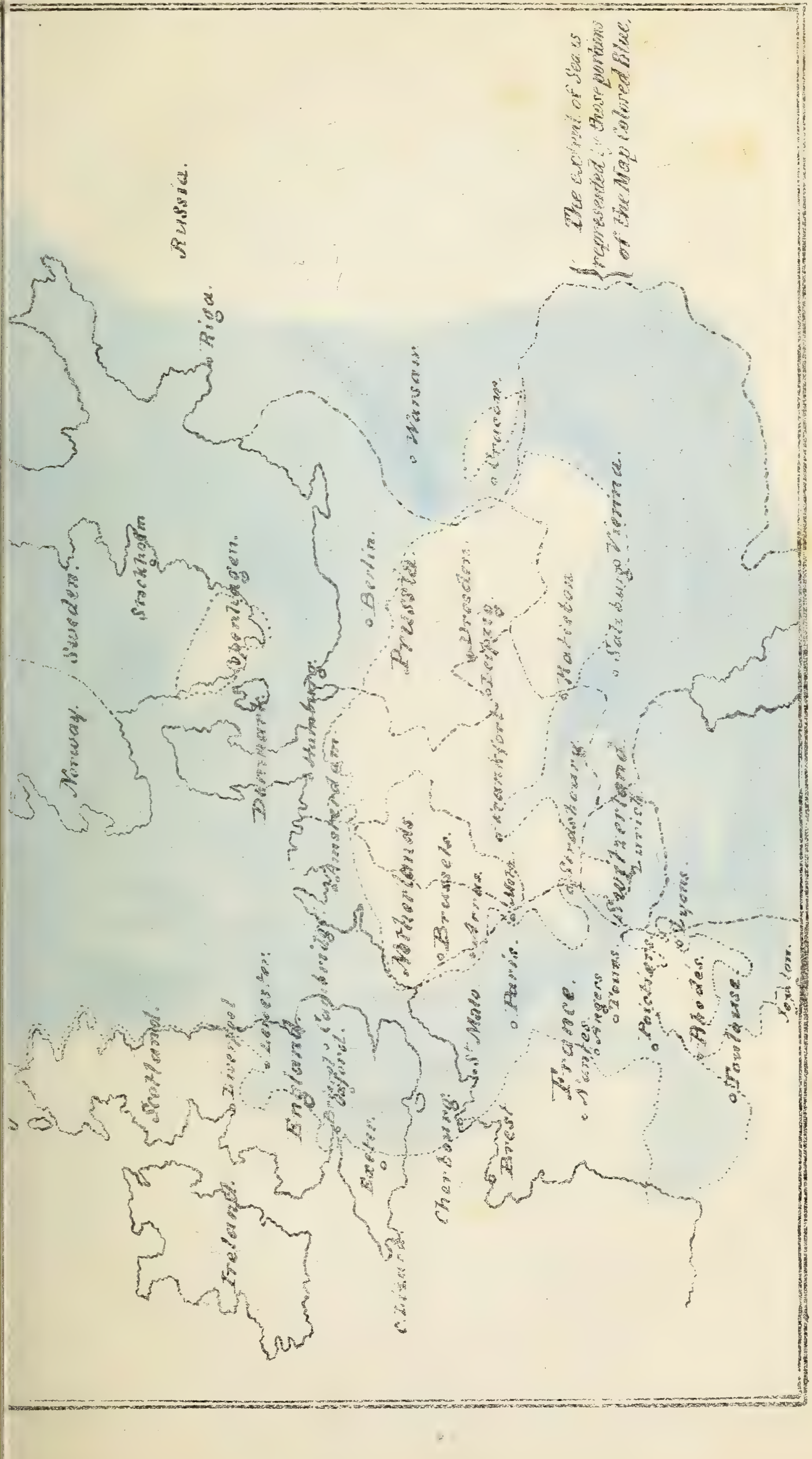
Extent of Sea in the Cretaceous Period in Europe.



The extent of Sea is represented by those portions of the Map colored Blue

PLATE I. Fig 2

Extent of Sea in the Jurassic Period in Europe.



The extent of Sea is represented by those portions of the Map colored Blue.

BRITISH MUSEUM

Grammatophora Mexicana.
Navicula Campylodiscus.
Navicula crucigera.
Spirulina vivipara.
Biloculina tenella.
Textilaria plicata.

Silliman's American Journal of Science.

On the Comparative Extent of Land and Sea during the Jurassic and Cretaceous Epochs. Compiled from M. Elie de Beaumont and F. S. Beudant.

In considering the geology of Europe, one of the most important circumstances which presents itself to our consideration is the geology of that district immediately surrounding the Thuringerwald—these mountains, of which the Boehmerwald is a continuation, form the natural boundaries between Bavaria and Saxony and Bohemia. Their range from Cassel to Lintz, affords us evidences of the most important disruptions which have occurred in the triassic series, and the jurassic formations are disposed on their highly inclined sides in horizontal layers. This system exists in other portions, though without offering any traces of the same striking phenomena, if we except the environs of Avallon and Autun in France.

This disruption may therefore be considered as having produced but little effect on the surface of the globe, although doubtless, it constituted one of the most important eras—on account of the entire change in organic life, and because the deposition of the jurassic beds, around the more elevated portions of the triassic rocks, has recorded their exact boundaries, and has thereby enabled us to institute a comparison as to the extent of land and sea at this period, and which we have figured in Plate I. fig. 2, from the authority of M. Elie de Beaumont. It represents the state of Western Europe after the sixth great catastrophe to which it was subjected, viz. on the upheaval of the triassic series.

The first fact which appears from inspection of the chart is the then extension of the sea over those districts in which our most flourishing cities now exist—the sites of London, Paris, Berlin, Milan, Florence, Rome, Naples, Madrid, &c., were all submerged, as also the present situations of the most lofty mountains, such as Mont Blanc. A vast extent of land existed in Scandinavia—the gulf of Bothnia was not formed—Denmark, Hanover, Prussia, and Poland did not exist; but Silesia, Moravia, Bohemia, Saxony, Hesse, Rhenish Prussia and Belgium formed an extensive island in the midst of the ocean. The boundary of this island extended from Arras to Trèves, forming two large promontories, including the Vosges and Black Forest, Ratisbon, Vienna and Cracow, where a strait existed with a northwesterly bearing. Another promontory, very irregular in appearance, existed in the centre or south-east of France, joined by a very narrow isthmus to the Pyrennean district, which even then appeared, only in a very much less elevated character. Autun was on the sea-side, and the site of Lyons, although submerged, was situated near the shore together with Perpignan. A small island occupied the site of Toulon, and Corsica existed at no great distance. To the west the land extended from Poictiers, past Angiers, Cherbourg, Liverpool to beyond Edinburgh—the channel was not then in existence, and Ireland was united to this great continent.

The ocean which surrounded these islands possessed its peculiarities also. The Spiriferæ and Producta had long since disappeared, and several species of Terebratulæ were the only remnants of the tribes inhabiting the former seas. Chambered shells (ammonites) then appeared for the first time, belemnites also appeared, as well as marine saurians and Pterodactyli; it was during this period also that those extensive coral beds existed, which have subsequently been traced in the coral rag formation.

Lakes and water-courses existed in the extent of land which favoured the growth of Paludina, and those species of Helix which we find in the Portland oolite.

However, we will not dwell at too great length upon the productions peculiar to this epoch, either in the animal or vegetable kingdoms; these are subjects with which the geologist is already well acquainted, and which do not require repetition.

The Côte-d'or affords another example of a displacement which was of very general extent, and which contributed to raise the jurassic series of strata above the water-level, and with this the dispositions and form of the continents underwent considerable change. (Plate I. fig. 1.)

If the three great islands of the preceding epoch were joined together this would present but an imperfect view of the alterations effected by the change alluded to. Brussels, which had been situated inland, was now near the sea; Arras, Dunkirk, Maestricht, Wesel, Breslaw and Vienna were situated beneath the water; a lake was formed between Dresden, Brunn and Prague; a strait existed over the present sites of Perpignan and Carcassone; and what existed of the Pyrennean district was now submerged.

The Vosges, which in the preceding epoch formed the sea-boundary, now existed in the interior of a large continent which was connected with the central island of France—the strait which separated them during the preceding period was now filled up. Langres, Nevers, Lyons, Toulouse and Oxford existed on "terra firma," and an isthmus was formed in the neighbourhood of Poictiers connecting the central land with that situate to the west. A boundary of land extended from Cracow to Perpignan, by way of Ratisbon (unchanged in its relative position in the former period), Zurich and Lyons.

An immense bay existed between Brussels and Oxford, and extended southwards as far as Poictiers.

Between Saltzburg and Avignon another new island was formed which represented the locality of the Alps; Briancon, Turin, Trente, and Inspruch existed, but Switzerland was occupied by a canal which separated the island in question from the continent. The island of Toulon was more contracted, and the environs of Marseilles were indicated by several smaller islands.

The fauna of the period was however but little changed—if we except the first appearance of dicotyledonous plants closely allied to those of the present time.

On the Lignite of the Environs of Bacton. By Charles Green, Esq.

This name has been given to extensive forest beds containing much carbonized wood.

The deposit prevails very generally along the Norfolk coast, and may be instructively examined at Happisburgh, Bacton, Mundesley, Trimmingham and Cromer; at Bacton extensive sections are laid bare after high tides; they are mostly formed of black peaty earth, which may be separated into thin layers, and has generally an aluminous taste, and abounds with pyrites; the depth of these sections, from the top of the cliff, is about five feet, at Ostend (between Bacton and Happisburgh) about thirty, and at Mundesley one hundred feet. These deposits are occasionally mixed with masses of red sand containing pipes of hard clay.

This formation presents every appearance of a wood having been overthrown and crushed *in situ*, for after strong north-west winds, the stumps of trees may be seen really standing, with the roots strong, spread abroad, and intermingled with each other. In the winter of 1840—41, I measured some of these trunks, which were then exposed, about a foot from the root; one of them measured five feet eleven inches round, and another five feet. At Ostend these trunks are often several yards round, and are thrown down indiscriminately in the strata. Some measure as much as nine or ten feet in length. Branches, leaves, crushed grass, fir-cones, and numerous seed vessels occur, of which those of the oak and fir are distinguishable.

In some parts, as at Bacton, the elytras of beetles, with mammalian remains, occur. The principal elytra are of the tribe Donacia. When first removed from the earth they are very brilliant, but the colours soon fade upon exposure to the air.

The mammalian remains include bones and teeth of the deer, horse, ox and Arvicola.

Whilst at Bacton this bed is formed of black peaty earth, at Ostend it is mixed with a greenish sand. Mr. Lyell speaks of that at Happisburgh as "laminated blue clay, about one foot and a half in thickness, part of the clay being bituminous, and inclosing compressed branches and leaves of trees." Mr. R. C. Taylor, in his "Geology of Eastern Norfolk," observes of the deposit generally, "it consists of forest peat, containing fir-cones and fragments of bones, in other parts, of woody clay; and elsewhere, of large stems of trees, standing thickly together, the stems appearing to have been broken off about eighteen inches from the base. They are evidently rooted in the clay or sandy bed, in which they originally grew, and their stem, branches and leaves lie around them, flattened by the pressure of from thirty to three hundred feet of diluvial deposits. It is not possible to say how far inland this subterranean forest extends; but that it is not a mere external belt is obvious, from the constant exposure and removal of new portions at the base of the cliffs."

The Rev. James Layton, cited by Mr. Fairholme in his geology, states in a letter, "The line of crushed wood, leaves, grass, &c. frequently forming a bed of peat, extends just above low water mark. About this stratum, numerous remains of mammalia are found, the horns and bones of at least four kinds of deer, the ox, horse, hippopotamus, rhinoceros and elephant. These fossils are found at Happisburgh and its neighbourhood, on the denuded clay-shore: at Mundesley they are found in the cliff."

The forest appears to extend far inland, for I have been credibly informed, that when the river Ant (North Walsham canal) was cut, a bed of peat was met with, precisely the same as that before described, containing fir-cones and nuts, with bones of the deer and other animals.

This stratum may be seen as the underlying formation along the whole line of beach from Happisburgh to Mundesley.

Mr. Lyell mentions this forest bed as having been seen also at Sidestrand, about a mile and a half north-west of Trimmingham, where the cliff, composed of drift, is 120 feet high. It consists of beds of laminated blue-clay and sand, six or seven feet thick, in which are some stumps of trees three feet in diameter, broken off to within a few inches of the roots, which spread for a distance of several feet on all sides. At the point near the bottom of the cliff, a stratum of clay has been seen in which freshwater shell of the genus Unio abound—apparently *unio ovalis.*

At Cromer, Mr. Simons has observed beneath the drift, several feet below high-water mark, a bed of lignite, in which are found the seeds of plants and the wing case of a beetle. This lignite contains coniferous woods and cones of the Pinus abies or spruce fir, a northern species not indigenous in Britain.

Mr. Simons also saw at Cromer ten or more trees in the space of half an acre exposed below the cliffs to the eastward of the town, the stumps being a few inches, or all less than a foot, in vertical height, some of them no less than a foot in girth, the roots spreading from them on all sides, throughout a space twenty feet in diameter.

Mr. Rich. Taylor believes this bed, as visible at Happisburgh, to be an extension of the well-known stratum at Watton cliff and Harwich, "There is," he says, "evidence sufficient to prove that it extends more south than Palling, even as low down as Winterton, and Caistor, also at Lowestoff."—*Green's Sketch of the Geology of Bacton.*

On the Fossil Fishes of the Manchester Coal-field. By E. W. Binney, *Esq.*

The following remarks are extracted from an essay on this subject, published in the first volume of the Proceedings of the *Manchester Geological Society*, to which we have briefly adverted on former occasions, but which are therein published in a more intelligible form, and therefore the better calculated to record the facts. It is not the intention to give a full description of the various genera and species, but merely to enumerate them.

Megalichthys.

The remains of this extraordinary genus of sauroid fish are not very common in the Pendleton coal-field, although found in abundance in the Ardwick limestones, and Bradford coal-measures in the ascending—and the canal of Wigan, in the descending series of the carboniferous strata. Detached scales, and a large tooth, exceeding an inch in length, obtained by myself, and several teeth found by Mr. Ray, are the only specimens that have been met with in this locality. They all belong to the species *M. Hibberti.*

Holoptychius.

This fish occurs in great abundance at Pendleton, and several entire specimens have been discovered of individuals ten and twelve feet long. Its whole figure resembles that of a true fish more than that of the megalicthys.

Palæoniscus.

Specimens of this genus, named *P. Egertoni* by Prof. Agassiz are found in the Pendleton coal-field; but they are not common. The best hitherto met with, is one which shows all the bones of the head and the various shaped scales, having rough tesselated outer surfaces, some nearly rhomboids, and others acute angles.

Diplopterus.

Scales and jaws of a fish of this genus are sometimes found.

Platysomus.

A fish of this extraordinary genus, nearly entire, two inches and a quarter long, and one inch and three quarters broad, as well as a larger one, were both found by myself.

Cœlacanthus.

Two entire specimens of fishes of this genus have been found; the largest is five inches, and the smaller about two inches long.

Gyracanthus.

Large bony rays of a fish of this genus are found detached—the fragment in my possession, three inches long and one inch in diameter, is probably the *G. formosus* of Agassiz. This fish belongs to the Placoidean order, and to the family of Cestraciontes, so named from their approah to the *Cestracion* of New Holland.

Diplodus.

Detached teeth of the *D. gibbosus* are found in this locality; they have three prongs of irregular sizes, springing from a solid oval base of bone, those on the outer sides being the largest, and the central one much smaller, all thickly coated with enamel. From the shape of the base, in which two orifices for the insertion of blood vessels appear, most probably they were inserted into cartilage.

Ctenoptychius.

Detached teeth of this genus occur at Pendleton. Like those last described, they belonged no doubt to a cartilaginous fish. They consist of solid pieces of bone coated with enamel, having their edges toothed like a comb.

Ctenodus (?)

A palate with a rough triturating surface is found, but whether it belongs to this genus it is difficult to say. Specimens of the five last genera are rare at Pendleton when compared with the number found at Ardwick and Bradford, but they are generally met with near together; whether they all belonged to one fish, or to different individuals, it is difficult to say; but, on comparing the three teeth with those of the Anarrhichas lupus or wolf-fish, it does not seem impossible, as the three kinds of teeth of that fish are fully as different in their characters as these.

The condition of the fishes—many of which, especially those in the deposit of very black Bass, are perfectly entire, with their fins extended and not a scale displaced, except from the pressure which the bodies have been subjected to, from the overlying strata, when in a soft state—seems to prove that they died on or near the places where they are now found, and that they have not been brought from a great distance.

The total absence of mollusca and crustacea in the strata where the specimens are found, appears to indicate that the water from which they were deposited was not much fitted for animal life, as both shales, above and below the schist where the fossils occur, teem with remains of a *Cypris* and *Microconchus*. Wherever these latter occur no entire fishes are to be met with, they having doubtless consumed all the edible portions and scattered the scales and bones. The analysis of the shale shows that the water in which it was deposited was probably of such a deleterious character*, from the quantity of decayed vegetable matter it contained, as to prevent the existence of fishes, mollusca or crustacea†.

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* Geologist, vol. i. p. 57.

† The following is an analysis of the very black Bass, made by Mr. John Dale, chemist, of Manchester.

Bituminous matter	16 per cent.
Oxide of Iron	3 "
Silica	18 "
Alumina	59 "
Water and loss	4 "
A trace of oxide of Manganese	
	100

MISCELLANEA.

Bones of the Ichthyosaurus in the chalk of the Austrian Alps: These bones are found at Reifling, on the road from that place to Palfau, near the confluence of the Salza and Enns. The portions discovered included the bones of the head and cervical vertebræ. The teeth resemble those of the Ichthyosaurus platyodon. Dr. Unger, who records the fact in the Gazette de Vienne also states that saurian remains have been found in the secondary chalk of the mountains of Wildalp (Austria). *(Annales des Sciences Geoligiques.)*

Fossil species of the Rhinoceros. The skull of a species of Rhinoceros not existing at the present time has been found at Montpellier, in connection with a quartzose block, buried in marine sand of the tertiary age. The species was one-horned. *(Idem.)*

On Fossil Horns of the Stag in Lithuania. Fossil stag horns have frequently been met with in bogs and argillaceous deposits, principally of two species—Cervus primigenius and C. priscus, very different from the C. elaphus. M. Waga has however discovered an entire new species in the bogs in the neighbourhood of Brzesc, Titewski, and Miecliaviec; it is most nearly allied to the C. pricus, but differs from it in many particulars, and M. Busch, to whom the remains were forwarded, has given it the name of *C. Bresciencis.* *(Neues Jahrbuch.)*

Fossil footsteps in the New Red Sandstone of the environs of Jena. M. Feldman has communicated to Messrs. Koch and Schmid that he has discovered footsteps in relief in the new red sandstone on the road from Jena to Kunitz evidently of animals of the genus Cheirotherium: the following are particulars of them.

1. Impressions (10 inches and 11 lines in length) of footsteps of the Cheirotherium of Hessburg.

2. Eight or ten imprints of three individuals belonging to the Cheirotherium of Hessburg, and about 5 to 10 inches in length

3. Numerous tri-digitated imprints, disposed parallel to one another. and probably of a new species.

4. Raised impressions of a horse-shoe form, nearly resembling but smaller than those found at Polzig.

5. Irregular impressions, somewhat resembling those found at Zenker, but considerably smaller; but both the fourth and fifth occurrences are as yet unexplained. *(Idem.)*

The Hot Blast Patent. This patent expired on the 11th Sept. 1842 in England, and on the 1st October in Scotland, and has proved one of the few which are eminently successful to the inventor. Besides being of great national benefit, it has realized a sum of not less than £150,000 to the patentees, and has placed John Beaumont Neilson high in the ranks of the benefactors of, not his country alone, but of mankind, iron being the most useful of the metals, and its cheap production of immense importance in arts and manufactures.—*Times, Nov. 25th,* 1842.

Euclase.—This rare mineral is found in its gangue at the topaz and fluor vein of Mr. Lane at Trumbull, Connecticut. It occurs in thin, transparent, yellowish white, tabular crystals, lining cavities in a silvery white mica, and sometimes imbedded in a dark purple fluor.—(*Amer. Journ. of Science.*)

Earthquake at Baroda.—A severe shock was felt early on the morning of 9th October, 1842, at the above place, the bearing of which was N.N.W. to S.S.E. It had been preceded by a long series of changeable weather, which terminated in eighteen hours heavy rain immediately before the shock was experienced, and at the time of the shock, the wind was S.W. with a clear sky.—*Morning Herald.*

An earthquake was felt on the 12th Nov. 1842, at Montreal, Three rivers, the St. Maurice, Torges, and other places. There was a sudden sound, a rumbling noise, and an explosion like a 24-pounder, a violent trembling of the earth, the rocking of houses, the cracking of walls, and various other phenomena. But little damage was done.—*American correspondent of the Times.*

Description of Strata passed through in sinking an artesian well at the Surry County Lunatic Asylum, at Springfield, Wandsworth.

	Feet.	In.
Yellow clay intermixed with veins of sand	30	0
London clay, with large clay stones	211	0
Sand, with clay and shells	6	6
Dark sand	4	0
Shelly rock.	5	0
Brown sand	1	6
Sand and Clay	2	0
Mottled Potters's Clay	4	0
Sand and Clay	2	0
Dark sand and shells	5	0
Pure light colored sand	1	0
Dark Sand	2	0
Sand and clay	1	0
Pink and yellow mottled clay	4	0
Light Brown and white clay	4	0
Dark red and white clay	4	0
Chalk and pebbles	1	0
Greensand	3	0
Variegated green and brown-sand	6	0
Green sand	4	0
Brown sand, wherein was water, which rose to within 36 feet of the surface	5	0
Fine dark gray sand	33	0
Sand and pebbles from which water rose to within 28 feet of the surface	2	0
A hard stratum (uncertain)	0	6
Chalk	1	6
Flints	4	0
Total	347	0

S. Lapidge, Assoc. I. B. A.

PROCEEDINGS OF SOCIETIES.

MANCHESTER GEOLOGICAL SOCIETY.

27th *October*, 1842.—The fourth annual meeting of this society was held this evening, JAMES HEYWOOD, Esq., F.R.S. in the chair. Both the report of the Council, and the prefatory remarks made by the chairman and Mr. Binney, showed an increasing activity and prosperity, and noticed particularly the resolution which had been passed to the effect that the museum of the society should be open every day from 10 to 4 o'clock—an ample proof of their efficiency. It was also announced that the premiums offered for the first and second best sections of the Lancashire, Cheshire and Yorkshire coal-fields had not been awarded, as only two competitors had appeared, and their respective sections had already appeared in print. It was resolved that the report of the Council be adopted and printed for circulation; subsequently votes of thanks were passed to the officers of the Society, and to the Secretaries, and Messrs. Ormerod for their assiduity in completing the arrangements of the museum previous to the visit of the British Association.

Mr. Ormerod then read an essay " On the Geology of Central Cheshire," which we have reported at considerable length under the head of " Memoirs" in this number.

After the usual business had been transacted the members adjourned to dinner at the Adelphi Hotel.

The following is the list of the Council for the ensuing year.

President.—James Heywood, F.R.S.

Vice-Presidents.—Ralph Thicknesse, jun.; Lord F. Egerton; Lord Bishop of Norwich; Sir P. de M. Egerton, Bart.

Treasurer.—George W. Ormerod, F.G.S.

Secretaries.—E. W. Binney; M. Dawes, F.G.S.

Council.—T. F. Bateman; Dr. Black; Capt. T. Brown, F.L.S.; Dr. Clay; Rev. George Eaton; Thomas L. Gooch; John

Hawkshaw, F.G.S.; Eaton Hodgkinson, F.R.S.; J. R. Lingard; Dr. Lyon; John Moore, F.L.S.; H. M. Ormerod; Rev. Robt. Wallace; George W. Wood, M.P., F.G.S.

SCIENTIFIC SOCIETY OF LONDON.

October 5th, 1842. The fifth session of this Society was opened this evening, George Alexander, Esq., F.S.A. V.P. in the chair.

The Secretary read a memoir, by James Buckman, Esq., "On a specimen of *Ichthyosaurus tenuirostris*," found by him in the neighbourhood of Bredon, Gloucestershire," and which was rendered remarkable by the excessive size of the orbit of the eye—the paucity of teeth—the coprolitic matter with which it was surrounded, and withal the beautiful preservation of the whole upper portion—we alluded to the discovery of this rare specimen in our last May number (vol. i. p. 163). The coprolitic matter did not assume the usual contorted or rolled form, but filled the instertices between the ribs, and extended a considerable distance around the lower portion of the animal—and evidenced that the unmasticated food of which it was formed had not passed through the intestinal canal at the period of the destruction of the animal, whilst the small number of teeth, and more especially the size of the eye, denoted it at once to be a young specimen—the latter being only a trifle larger in the adult than in the young state of any vertebrate animal.

Oct. 19, 1842. George Alexander, Esq., F.S.A. and V.P. in the chair; and Nov. 2, 1842, Charles Moxon, Esq., Treasurer, in the chair. The meetings on both occasions were occupied by an essay "On Electrotype," by Thomas Damant Eaton, Esq.

Nov. 16th, 1842. The sixth anniversary meeting was held this evening, A. Marshall, Esq., in the chair. After the usual routine busines had been completed, the chairman placed in the hands of the secretary (Geo. F. Fordham, Esq.), the premium which the Society had awarded to Mr. James Buckman for his essay on "Phytography," and in so doing, requested him to convey to Mr. Buckman the especial thanks of the Society for his elaborate essay, which he said, would be submitted at an early meeting, and also for the uniform zeal which he had manifested in their affairs, and which he trusted would emulate others to follow his example. The treasurer then delivered the annual address, in which he reviewed the proceedings of the past session and demonstrated that the objects of the society had been fulfilled both in respect of their nature and general character, after which the members adjourned to supper together.

REVIEWS.

LOCAL GEOLOGY.

2. *Collections illustrative of the Geology, History and Antiquities of Camberwell. By* Douglas Allport, *printed for the Author,* 1841.

We have to recommend that portion of the above work, descriptive of the Geology of the neighbourhood, as well worthy the perusal of scientific men, for, although brief, it is exceedingly well-designed, and contains much interesting information, both as to the stratification of the London basin, and the fossils which have been found—these are illustrated by well executed woodcuts, which give additional value to the memoir. The introductory portion of this section of the work, is excedingly well worth attention. "The strong prejudice," says Mr. Allport, "which exists against topography generally, arises very probably from the fact that it seldom proceeds upon philosophical principles—the philosopher finds 'all in all,' and there is no reason why the local historian should not be a philosopher. History, indeed, in its unlimited range, is a theme of such magnitude, that we are compelled to divide and apportion it, and this apportionment gives rise to local history," and it is therefore in following out this excellent idea, that our author, regarding geology only as another name for early history, has placed it first in his work, the whole of which will throw much light upon the points under consideration; and if others are as interested in local records as ourselves, will amply repay a careful perusal.

2. *A few Remarks on the Geology of Bacton. By* Charles Green, *Norwich,* Josiah Fletcher, 1842.

Mr. Green has compressed within the limits of his small work so large a mass of information as we have rarely seen in any memoir on local geology, and has proceeded upon the laudable system, not of bookmaking, but of condensing and placing before his readers as much as has been done with respect to the subject in as short a statement as possible; with one exception he has treated the facts so that they may be intelligible to the tyro in geology, and points out to him the peculiar nature of the situation of Bacton—the constitution of the cliffs and soil, and the fossils found in them—we cannot say more as to the merits of the author, but the subject offers many points for profitable enquiry. We have given elsewhere an extract of the chapter on the "Lignite of Bacton," and we will in this place merely add that the several strata may be studied with considerable advantage, as they are principally local deposits, and their contents vary considerably from others which agree in lithological character and might otherwise be considered identical.

MEMOIRS.

On several new species of Encrinite and Hypanthocrinite from the neighbourhood of Dudley. From a report by the Curator of the Dudley and Midland Geological Society.

In the observations which the committee of the Dudley and Midland Geological Society made in the first report laid before the society, at its formation in January 1842, with regard to the complete series of fossils from the Silurian rocks of the neighbourhood which their museum at that period contained—complete, indeed, so far as the then existing knowledge extended—they ventured to remark, that numerous as were the various genera and species already known, they yet felt confident that new discoveries in this interesting field would be continually made, to reward the careful and persevering research which they hoped the establishment of this society would encourage.

The fortunate results which have attended the researches of several of its members, even in the short period which has since elapsed, have fully justified these expectations. During the past quarter, several very beautiful and perfect specimens have been discovered of that peculiar fossil to which the curators alluded in the first report as partaking of characters allied both to the pentremite and encrinite, although essentially different from either. The body is composed of irregularly shaped plates. It is divided into four parts, by bands apparently running down from the top of the body, and reaching nearly, in some specimens fully, to the point where the column and body join. In some instances, two of these divisions are larger than the others, and may be called the front and back of the fossil, the two smaller divisions forming the sides. It is, however, possible that this apparent irregularity, which is not evident in every specimen, may result merely from unequal compression. Each of the four bands possesses a double row of small rays, and one of the great peculiarities of this fossil is the presence of some curious slits or openings in the plates of which the body is composed. One of these slits is to be found in each of the four parts into which it is divided, situated alternately in the upper and lower portions of the divisions. What purpose these openings may have answered it is difficult fully to understand, but they are evident in all the specimens known, and must have performed some important function in the animal economy of the living individual. This fossil differs both from the pentremite and encrinite, in being divided into four parts instead of five.

In addition to these specimens—valuable as extending our knowledge of a genus so recently discovered, and possessing so many peculiarities—several entirely new species of encrinites were also described in the report. One of these is a remarkably fine specimen, and being entirely detached from the matrix, shows the general character of the fossil very beautifully. It must have belonged to a large species, and its chief distinctive mark seems to be in the unusual breadth of the rays where they proceed from the upper plates of the body. Another must have belonged to a species by no means so large as the last, but it possesses several striking peculiarities, especially in the strength of its plates, and the curious cup-like shape which they assume where the arms proceed from them. It is altogether a remarkable specimen. Besides these, a specimen of another new species was noticed; though decidedly different from any previously known, it was not however considered sufficiently peculiar to require any detailed notice.

The specimens of encrinites hitherto discovered in the formations of Dudley have disclosed very little of the interior structure of the fossil; this was the more to be regretted, because belonging to that peculiar class of zoophytes which seem to form a connecting link between the animal and vegetable kingdoms, any insight into their interior anatomy would have been of great interest. The stomach, as the receptacle of its food is termed, is generally hidden beneath the surrounding rays, and there were few specimens known which gave any idea of its peculiar form, until this was disclosed by cutting the fossil through and grinding down and polishing the section thus obtained. But although the interior of the stomach was thus shown, we were still ignorant of the shape and appearance of its exterior surface. One or two specimens are, however, now in the museum of the above society, which supply this desideratum, and which, together with the sections just alluded to, enable us to understand thoroughly the whole of that internal portion of the encrinite which in ordinary specimens is completely concealed from view.

The possession of several new specimens of the hypanthocrinite, hitherto a rare species, has enabled this society to obtain both cross and lateral sections of this fossil. These sections show distinctly the very curious arrangement of the interior, composed of solid plates of bone, radiating from the central tube which connects the mouth or proboscis with the stomach, and enclosing between them the long delicate rays of the encrinite.

This curious and anomalous genus was first of all described and named by Professor Phillips, in Mr. Murchison's "Silurian System." Its outward appearance is essentially different from that of any other known genus. The whole of the pinnæ which proceed from the rays, in all the specimens hitherto discovered, are closely packed up and nearly or entirely concealed from view. The encrinite in this closed state assumes an almost perfectly round shape, somewhat cylindrical, the surface of which is entirely composed of the rays and the solid ribs, alternating between each pair of rays, and which, as will afterwards be seen, constitute such an important peculiarity in its structure, while the whole is surmounted at the crown by the mouth of the encrinite. It would naturally be expected that the general arrangement of the mouth, with the rays enveloping it, would be such, that the food, after being collected and secured by the reticulated fingers or rays, could be easily conveyed to it. But in this genus, the mouth being elevated above the rays, seems carefully put out of their reach; and it is difficult to discover how the food was conveyed to it, except by supposing a great degree of flexibility in the long bony structure of the tube at the extremity of which the mouth is placed, and of the plates supporting it. These bony plates or ribs rise between each pair of rays, proceeding alternately from single and double plates. They reach nearly to the top of the rays in one solid piece, where they are further continued by other plates of a similar substance, until they terminate around and immediately underneath the mouth. The cross section shows that these ribs are of a wedge shape, and run in nearly to the centre of the specimen, where they are united to a tube about one-eighth of an inch in diameter, and which is seen in the vertical section to connect the mouth with the stomach. Thus the plates which surround the mouth are supported upon a strong scaffold, composed of ten upright ribs, united together in the centre by the tube which connects the mouth with the stomach, and from the length both of this tube and the ribs as well, the mouth must have been kept out of the reach of the rays, except by supposing (as previously suggested,) that the whole of this curious structure possessed a great degree of flexibility. The principal objection to this is furnished by the apparent strength of this scaffolding, which is so strong, that in some specimens, where the pressure has been sufficiently great even to compress the sides of the stomach, the body of the encrinite has still preserved its round form.

The report proceeded to state that the curators were, however, now engaged in endeavouring to throw a greater light upon this curious point; and that, as the possession of so many specimens gave them an opportunity of carefully dissecting several, they hoped to be able, in a short time, to explain more satisfactorily than they can now do, the peculiar structure of this fossil.

The most important and beautiful discovery has however yet to be mentioned. The society's museum has, ever since its commencement, contained the body of an encrinite of a remarkably globular form, the plates of which approach very much to the character of the cyathocrinites rugosus of Miller; but although several specimens of this peculiar encrinite were known, showing the body, none had been found which gave any idea of the character of the column, or of the rays. As these specimens were evidently portions of a new species, they were looked upon as valuable, because they added yet another to the great variety of the crinoidea which our Silurian rocks contain; but no idea could be formed of their real importance, nor was there anything to lead to the supposition that they belonged to an entirely new form, possessing peculiarities distinguishing it from all previously known species. The discovery of a specimen perfect, as far as regards the body and upper portion of this encrinite, has, however, now disclosed this important fact, while it has added not merely a new form to the almost infinite variety with which we were before acquainted, but has presented us with one which may perhaps be said to surpass all others in the beauty of its shape and the extreme delicacy of its structure. To the naked eye, the rays which proceed from the upper portion of the body appear to form a beautiful kind of coral net-work, but the microscope enables the observer to detect, in the threads which apparently run across the specimen, small tubercles on each side of the branches of the ray, so regularly placed, at equal distances, as to correspond on a perfect line with one another, though most probably, really divided, and each pair of tubercles is attached to a separate joint of the ray. Some idea may be formed of the minute subdivisions of the beautiful structure composing the upper portion of this encrinite, when it is stated that there are about seventy-three joints to each branch of the ray, twenty-five branches to each ray, and five separate rays; and that thus, in this single specimen, there are upwards of 10,000 joints. Neither the joints of the body or column are taken into this calculation, and as the rays themselves are somewhat crushed together, and the ends broken off, while the number of the branches increase as the rays lengthen, it is possible that this number is much underrated, and that the skeleton of the animal, when alive, consisted of upwards of 20,000 joints. When it is remembered too, that each joint, judging from analogy, must have had two muscles at least, probably four, the extraordinary number and delicacy of the several parts, and the wonderful adaptation of each to accomplish the intention of the GREAT AUTHOR of all things, even in providing for an animal so low in the scale of creation, must call forth our unmingled admiration and praise.

It is almost impossible to form an adequate conception of the extreme beauty of appearance which this encrinite must have possessed in its living state. If however, the curators are right in presuming that the column which is connected with this specimen really belonged to it, and which in all probability it did, as it was found lying in the same bed, and very near to it, some idea may be formed of its imposing appearance. Rising from the top of a long flexible column, possessing an immense number of joints, we must imagine an almost perfectly globular cup, composed of a number of plates, each marked with delicate flutings. From the upper margin of these plates swells out the beautiful net-like tissue, formed by the innumerable subdivisions of the rays and their branches, the whole spreading into a magnificent cup or bowl, upwards of eight or nine inches in width at its upper surface, endowed with the most exquisite flexibility, and during the periods of the animal's activity, in a constantly undulating motion.

The discovery of one specimen of a new species is generally followed by that of many others, for it stimulates collectors to a more zealous search, and points out the line in which such search will most probably meet with success. Thus, only a few years have elapsed since the first specimen of Homalonotus delphinocephalus was found in this locality: it was previously not known to exist in the Dudley rocks, although met with at Ludlow, while so many specimens of it are to be seen, both in the society's museum and in the hands of private collectors as well, that it is no longer considered a rare fossil. Many similar instances might be mentioned, where the discovery of the first specimen of a new species has led, by inducing more careful research, and by pointing out the most probable line of success, to the possession of many others; and therefore the committee think they can scarcely overrate the importance of this single specimen, as it will probably lead to the knowledge of a new class, perhaps, containing in itself alone, many distinct varieties.

List of Fossils from the "Till" (Blue Clay of Woodward), of the environs of Bacton, and the formations to which they originally belonged. By Charles Green, *Esq.*

Littorina littorea	Crag.
Cardium Tellina } Fragments	Ditto.
Gryphæa	Lias.
Pholas crispata	Clay.
Pholadomya Murchisoni	Inferior oolite.
Cardium hillanum.	Green Sand.
Avicula inæquivalvis	Inferior oolite.
—— ovalis	Coral rag.
—— media	London clay.
Plagiostoma punctatum	Lias.
Terebratula crumena	Mountain limestone.
Ammonites ?	Ditto.
—— rotiformis	Lias.

—— maculatus	Ditto.
—— heterophyllus	Ditto.
—— Taylorii	Ditto.
—— serratus	Chalk.
Hamites gigas	Limestone.
Belemnites electrinus . . .	Chalk.
—— mucronatus	Ditto.
Echinus	Ditto.
Fragments of wood from the Forest Bed.	
Teeth and Bones of Icthyosaurus.	Lias.

(Green's Geology of Bacton.)

PROCEEDINGS OF SOCIETIES.

ASSOCIATION OF AMERICAN GEOLOGISTS AND NATURALISTS.

Proceedings of the 3rd. annual session held at Boston, in 1842.

April 25th, 1842, Prof. Locke in the chair; the chairman exhibited sections of the *rocks of the lead regions of the upper Missisipi,* with remarks on the Geology of the west.

I. A section from the heights of little Mohaqueta through Dubuque Mines, to Suisinawa Mound; fifteen miles. This section exhibited:

1. The cliff limestone, containing lead veins in the middle and lower portions.
2. The blue limestone, (Trenton limestone.)
3. Presumptively the lower magnesian underlying the blue.

II. A section of Prairie du chien exhibiting the following rocks, descending series.

	feet.
1. Soil and cliff limestone	60
2. Blue fossiliferous limestone	115

	feet.
3. Buff colored limestone	20
4. Soft saccharoid sandstone	40
5. A portion covered by soil	40
6. Brown magnesian limestone, resembling the cliff lithologically, but is nearly destitute of fossils	190
This last is exposed only at low water	495

III. A section from Blue mounds to Wiskonsin River, exhibiting the following descending series of rocks:

1. Beds of siliceous chert, containing the fossils of the cliff, and forming the peaks of the mounds	410
2. The cliff limestone, containing lead ore in its lowest portion	169
3. The blue fossiliferous limestone, very thin, sometimes wanting	0
4. Saccharoid sandstone	40
5. Alternations of saccharoid sandstone and brown magnesian limestone	188
6. Sandstone	3
7. Lower magnesian	190
	1000

By lower magnesian limestone is not meant the magnesian limestone of Europe. The name was given by Dr. Owen, in contradistinction to the cliff limestone, (which is the upper magnesian,) both containing magnesia. The cliff limestone is properly divided in three portions, viz.:

Upper Beds—more regularly stratified, and less frequently vertically fissured than the middle or lower; also more rich in siliceous fossils, containing layers of chert, and indeed passing wholly into masses of flinty rocks, containing also good iron ore, and much crystallized carbonate of lime; but lead more rarely and in unprofitable quantities. The fossils most frequently found are Terebratulæ, several pieces of Catenapora, Calamipora, Columnaria tubipora, Aulopora, Sarcissula, Astrea, Cyathophylla, Caryophylla and Othocerites.

Middle Beds.—Aspect more arenaceous, though it contains but a small per centage of sand. Chert masses are rare. Stratification imperfect, and numerous vertical fissures. Rich in ores of lead and zinc, associated with iron in small quantities. The fossils are Coscinipora (sulcata? Gr.)—the only coralline, a Cirrus resembling perspectivus; Ampullaria, also impressions of spiral univalve, resembling Vivipara. It seems by the above that there is no absolute geological distinction between the middle and lower beds.

Lower Beds.—Also of arenaceous appearance, rather more distinctly stratified than the middle beds, and imbedding more frequently than these siliceous chert masses. They contain the same fossils and ores as the middle beds, with the addition of copper and sulphate of zinc.

April 26th, 1842.—Dr. Morton in the chair. Prof. Hitchcock submitted a paper *"On the Phenomena of Drift in the United States."* This essay was accompanied by a chart exhibiting the course of striæ and lines of dispersion of boulders.

Dr. Jackson objected to the remarks of Prof. Hitchcock on the ground that if we admit several different causes, it would be improbable that we should find that they had acted in nearly the same direction. The United States exhibit no proofs of the glacial theory as taught by Agassiz, but on the contrary the general bearing of the facts is against that theory; for we observe nowhere in that country a general radiation of detritus from the principal mountain ranges, although as in Rhode island, there is a divergence from the point whence the boulders are derived. This divergence is, however, merely a spreading of fifteen miles for forty in extent, and it is in the usual general direction of North American drift, to the southward; none of the boulders having been drifted to the north of their parent bed. Mr. Lyell offered some remarks with reference to observations in Europe on this subject, and was followed by Mr. Redfield, who stated that he had been led, from his limited observations, to infer that the drift of the region near New York *was the joint result of glacial and aqueous action,* and was mainly deposited during a period of increasing submergence. He alluded also to the agreement of the striæ of the polished rocks, and of the transported boulders and drift, with the known cause of the existing polar currents of the ocean, in the northern hemisphere; and suggested that this system of currents, being essentially the same in both hemispheres, and having its cause in the dynamics of the solar system, must have operated through all time, and over extensive regions, but varying in locality and direction with the changes of outline and relative levels of seas and continents, during the successive geological epochs.

Some remarks were next made as to the origin of mounds in the western states, which we omit, as little connected with geology.

Mr. Couthouy read a paper *" On Icebergs."*

The first he had observed was on May 28th, 1822, in lat. 42° 10′ N. and 44° 50′ W. long. (Greenwich), this was visible for eighteen miles. The second was on the eastern edge of the great bank of Newfoundland, lat. 43° 18′ N., long. 48° 30′ W. Thirdly, numerous others were met with by him in the summer of 1827, between the 36th and 42nd parellels of north latitude.

A large ice-berg was also seen by him in August, 1827, in lat. 46° 30′ N. and long. 48° W. stranded in eighty fathoms water. *Large masses of rock and quantities of earthy matter were imbedded in its sides, and the water for at least a quarter of a mile round it was full of mud, stirred up from the bottom by the violent rolling and crushing of the mass;* this movement was accompanied by a harsh grating noise, with occasional cracking reports, audible for ten or twelve miles.

In 1831 he had met with several small icebergs in lat. 36° 20′ N. and long. 67° 45′ W. which from their proximity to each other were evidently portions of a larger one, it having been forced into the warm north-east current of the ocean by a strong gale which had prevailed from the south-east. A strong north-west immediately following, drove them into pieces and left them in the position in which Mr. C. saw them, in an eddy current, setting south-west at the rate of half a mile per hour. Mr. C. drew some important inferences from this example—supposing an iceberg tossed from the north polar regions loaded with blocks of stone and gravel, and drifting southward, to strand upon the coast of Newfoundland, and thereby incorporating portions of it into the soil of that shore; unequal action of the weather upon it may have led to its turning wholly or partially over and with this change, suppose it to float off in its southerly course, till forced into the gulf stream and carried eastward at the rate of 24′ a day (the mean velocity of the stream referred to) till it was melted away. To effect this dissolution would require three or four months, during which time, the berg would be carried seven or eight hundred miles in a direction nearly at right angles with its primary drift, depositing a greater or less quantity of transported material along its entire track. This sufficiently explained, he thought, the deposition of rocky materials over a wide range of latitude as well as longitude.

Mr. C. had observed another iceberg on March 4th, 1841, in the Pacific, 283 feet in height, and two-thirds of a mile in diameter. This mass enclosed immense blocks of stone, some of them having a surface of twenty square feet. It rotated with incredible velocity on its vertical axis, and the temperature in the neighbourhood of it was as follows:

	Noon.	2 P.M.	3 P.M.	3½ P.M.	4 P.M.	4½ P.M.	5 P.M.	5½ PM
Air	54°	53°	50°	46°	42°	37°	35°	37°
Water . . .	50°	50°	48°	44°	43°	36°	36°	40°
Distance of berg	33′	19′	12′	8′	4½′	1′	3′	6′

It was for geologists to determine whether these were any evidence of ancient diluvio-glacial action analagous to such a mixed deposition, and irregular distribution of materials from widely separated localities, as that evidenced in the course of the glaciers alluded to.

In the evening Prof. Silliman delivered a most interesting address on the "Progress of Geological Science in the United States."

April 27th, 1842.—Dr. Morton in the chair. The consideration of the "Drift," question was adjourned to the next session. The objections to the views presented by geologists, are 1st, the washing up of ridges along the shores of lakes; 2ndly, those of glaciers; 3rdly, those of icebergs; 4thly, alluvial beds; 5thly, the accumulation of boulders along what were ancient coasts; 6thly and 7thly, pot holes and slickensides.

April 28th, 1842.—Prof. Silliman in the chair. Dr. C. T. Jackson read a paper "*On the Tin Veins of New Hampshire,*" exhibiting specimens of ore both crystallized and compact, and an ingot weighing three ounces of the reduced metal, obtained from five ounces of the ore, the accompanying minerals of the veins at Jackson, also specimens of the yellow blende of Eaton and the black blende of Shelburne, with a specimen of the associated lead ore.

Prof. W. B. Rogers adverted to the occurrence of oxide of tin in Virginia, associated with auriferous quartz and other minerals of some of the gold mines—he had found it but rarely, and then in the talco-micaceous slate, near its junction with the auriferous quartz. He also remarked that he had found the sulphuret of zinc sometimes, and the silicate (electric-calamine) very abundantly in the lead mines of Wythe Co. Virginia. The latter often occupies the greater part of the breadth of the vein, whilst the sulphuret is met with in nests and thin veins, in the sparry and magnesian limestone adjoining the lead ore. The same mines yield large quantities of beautifully crystallized white carbonate of lead, and a considerable quantity of the red oxide (native minium), and the yellow oxide has also been found there.

Dr. C. T. Jackson exhibited a specimen of meteoric iron from Caiborne Co. Alabama, in which he discovered chlorine in the form of chloride of iron and nickel. Prof. J. B. Rogers remarked on the analyses of meteorites, from Grayson Co. Virginia and Georgia, made by him, the former giving 6·15 per cent. of nickel and a trace of chlorine, and the latter, a granulated variety, 7 per cent. of nickel, without any indications of chlorine.

Mr. Redfield gave notice of the discovery of a new species of fossil footmark in the new red sandstone of Connecticut, at the well-known quarries at Portland. These are wholly unlike the ornithichnites described by Prof. Hitchcock, some of which have been found in the same quarries, but they have some resemblance to the Cheirotherium minus, which is figured in the "Bulletin de la Societé Geologique de la France."

Mr. Redfield also called the attention of the meeting to a new species of fossil fish from Sunderland, Mass. which seems referable to the genus Palæoniscus.

April 29th, 1842.—Prof. Beck, in the chair. Prof. W. B. Rogers read a paper "*On the Age of the Coal-rocks of Eastern Virginia.*" He described these strata as occupying parts of Chesterfield, Powhatan, Amelia, Henrico, and Goochland counties, and lying in basins of granite, the principal coal-seam being separated by only a few feet from the floor of the primary rock. In some places near the margin of the field, where alone they have been explored, the thickness of these coal-rocks is 800 feet, but it is probably somewhat greater towards the centre. Throughout much of this depth they consist of coarse grits, often composed of the materials of the granite so little worn, as to present the aspect of this rock in a decomposing state. Prof. Rogers showed, on the testimony of fossils, that the age of these rocks instead of being older than the carboniferous formation of the west of Europe, was more nearly allied to that of the bottom of the oolite formation of Europe. The prevailing fossils are of the genera Equisetum, Tæniopteus, and Cycadites or Pterophyllum, and either agree specifically or correspond nearly with those of the oolite coal of Brora and the equivalent beds at Whitby, &c., this presented, in Prof. Rogers's opinion, a striking analogy with the abnormal development of the lower oolite in certain parts of Europe.

Prof. W. B. Rogers communicated a paper " *On the Porous Anthracite of Eastern Virginia.*" This essay was on the cause of the peculiar texture of this material, which the author ascribes to the thorough carbonization and desiccation of the vegetable matter before it was *sealed in* by the overlying strata.

Prof. W. B. Rogers next read an essay " *On the Connection of Thermal Springs in Virginia with anticlinal axes and Faults.*" In this he gives a list of more than thirty thermal springs having an excess of temperature over the ordinary springs, of from two to nearly sixty degrees. These are all situated in the Appalachian belt, and without an exception issue on or near the line of an anticlinal axis or fault, or near the contact of the Appalachian with the Hypogene rocks. Prof. Rogers laid much stress on the fact that the warmest of these springs were generally those which issued from the lowest formations.

Prof. Rogers also submitted a paper " *On Observations on Subterranean Temperature made in the Mines of Eastern Virginia.*" This paper gave the results of observations with the thermometer at depths varying from one hundred to nearly eight hundred feet, all indicating an increase of temperature downwards.

Prof. H. D. Rogers, read a paper " *On the origin of the Appalachian Coal strata, bituminous and anthracite.*" This essay included, amongst other subjects, inferences respecting the position of the ancient carboniferous sea and coast—wide range of the coal-beds—these identified from basin to basin; also notes on the mechanical structure of coal, and inferences which prove that the persistency of the minor subdivisions of the coal-beds are inconsistent with the doctrine that the vegetable matter was drifted. The prevailing nature of the under stratum was remarked and the different compositions of the overlying rocks; these latter indicate a rapid motion of the waters, the under clay on the contrary a quiet subsidence of sediment.

Beds of marine limestone were found in contact with the coal-seams. There is also a regular gradation in the proportion of volatile matter in the coal as we cross the Appalachian basin north-westward.

Prof. H. D. Rogers presented more details in relation to *the striated surfaces of the north-eastern counties of Pennsylvania and the adjacent districts of New York,* proving, that while the scratches which abound on the summits of all the mountain ridges in that part of the Appalachian chain observe a nearly north and south direction, answering to their prevailing cause throughout New England, those on the sides and bottoms of the valleys obey with remarkable fidelity all the local deflections which a body of moving waters would encounter along the ridges and valleys of this entangled range. In the Wyoming valley, the summits of mountains elevated 2000 feet above the sea, and 1500 feet above the valley, are covered with parallel striæ, pointing a little W. of S., but on their slopes in the bed of the valley these lines follow other dircctions conforming to the course which any obstructed inundation would pursue.

Reviewing several of these circumstances Prof. Rogers concludes that the striæ were produced by the friction of the overlying drift itself, urged into rapid motion from the north by one or more sudden inundations. From the absence near the southern border of the striated region of granitic or other far transported northern boulders, he infers that floating ice had no agency in furrowing and smoothing the surfaces of the strata. The next meeting of the Association will be held at Albany on the fourth Wednesday in April, 1843.

SCIENTIFIC CONGRESS OF FRANCE.

Session held at Strasburg, September 1842.

1. *On the geographic distribution of colours in nature, by Prof.* Zenne.—After recapitulating the probable appearances of the primitive globe, he continues by stating that immediately after the influence of the light began to be felt upon the surface of the earth, the three primitive rays, red, yellow and blue, also began to exercise their influence upon the different zones of our planet. The red, the hottest of these rays, is more especially apparent in the torrid zone; the blue, on the contrary, being the coldest ray, predominates in the arctic, whilst the intermediary or yellow ray is displayed in the temperate zone especially.

2. *On the erratic phenomena and diluvium of Sweden and Norway, by* M. Daubree. The most singular fact in the district examined is, that the rocks are all rounded on the northern side, whilst the southern sides remain angular. Those which are rounded, and independent of their various degrees of hardness, are all furrowed by parallel striæ. M. Sefstrom announced several years since, that this mean direction in Sweden was N.N.E. by S.S.W.; M. Durocher remarks that the striæ in Lapland are in the direction of N.N.W. by S.S.E., but this constant direction is not found in the mountainous region of Scandinavia, particularly in Norway. It has been found that the striæ thus radiate from the elevated summits of the chain, and run in the direction of the principal vallies similar to their mode of occurrence in the Alps. These striæ have been traced below the level of the sea, for we find them in situations which were formerly 250 feet above the water level. In Norway they are covered by a deposit of clay in many instances, containing the remains of marine shells identical with those existing in the surrounding seas, and numbering upwards of 300 species; that the sea did not merely transiently cover them is proved by the abundance of serpulæ

which are found adhering to the striated rocks in the neighbourhood of Christiana.

3. *On the diluvial deposits of the Black Forest, by Prof.* FROMHERZ.—According to the opinions of the author of this essay, all the diluvial deposits of the Black Forest originate from that locality, which, he says, may be easily proved by comparing these deposits with the strata composing that chain of mountains. They are, in fact, the effects of large currents of water, which originated in the chain itself. These currents arose from the overflow of the great lakes which occupied the elevated vallies before and during the diluvial period, and which took place during that epoch, not only over the whole extent of the Black Forest, but the neighbouring country also, by dislocations and disruptions in the existing strata. The channels by which the waters of these lakes entered the plains, and which are now indicated by ravines and vallies, with more or less escarpments, all bear the impress of a recent formation.

The diluvial deposits of the district differ entirely from those of glacial origin; as moraines and striated rocks are altogether absent; those which are rounded in any way bearing evidence of other than glacial action.

4. *Observations made on the glacier of the Aar, in company with Messrs. Agassiz and Desor, by Dr.* VOGT.—The snow always falls in these elevated regions in the form of crystals, and not granular; frost occurs there as well as in the plains. The water which is derived from the melting of the snow exposed to heat, everywhere infiltrates the mass, and cements the separate crystalline particles; the transformation is more and more complete in proportion to the depth of the glacial mass. Every glacier presents a series of respective strata of snow, frozen snow, and snow-ice; these are nearly horizontal, and about 4½ feet thick, appearing to be the accumulations of several successive years. The surface of the beds is distinguished by the fragments and dust upon it. Colouring matter infiltrates equally through

the mass, until it meets with a new surface, where it stops; which at once proves the difference of the glacier from common ice.

5. *On the Geology of the environs of Niederbronn; by* M. ENGELHART.

This district of lower Alsace is thus constituted:—1. The triassic series of Alberti, resting on the Vosges. 2. The jurassic series, more or less complete. 3. The so called *Molasse**, of considerable thickness in some parts. 4. The marsh and silt of Bouxwiller, only traceable in a few patches, being covered in most instances by diluvium and alluvial formations. 5. Loess. —An accumulation of lime, clay and gravel, of a dirty yellowish grey colour, and containing grains of mica. The profile of Niederbronn to the extent of 2 leagues, embraces the Syenite of Jaegerthal, the sandstone of the Vosges (*gres vosgien)* and the triassic series, the beds of which are much dislocated by disturbances subsequent to the upheaval of the Vosges. The keuper *(marnes irisees)* are but imperfectly developed in lower Alsace. The calcareous grit or lias sandstone, which, in the neighbourhood of Oberbronn, covers the marls of the keuper series, incloses the same fossils as the calcareous grit of Lorraine and Luxembourg. The lias then succeeds, and is divisible into three portions:—1. The great lias bed, characterized by the *Gryphæa arcuata, Plagiostoma giganteum, P. Hermanni, Ammonites Bucklandii, A. Conybeari**, (the lias marl abounds in *Avicula inequivalvis.* 2. A bed of lias marl, which includes numerous ammonites, teeth and bones of fish, and *Astarte Voltzii, Nucula Hermanni, Gryphæa obliqua,* and other interesting fossils. 3. The upper bed distinguished by numerous *Ammonites primordialis,* and *Trigonia navis,* so common at Gundershofen.

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* A sandstone of granular texture, named by French Geologists, "*gres-tertiaire a lignites.*"

* These two fossils, and the Gryphæa, Avicula, and Plagiostoma are abundant in the lias beds of this country.

The inferior oolite is the only member of the jurassic series which is well developed, and contains granular ironstone, more especially abounding at Meitesheim and Gundershofen—greatly resembling that found at Kandern in Baden.

6. *Comparison of the lias of Metz with that of Niederbronn, by* M. SIMON.—Masses of ironstone are abundant in the lias of this district, not sufficiently rich however for working; neither *Gervillia* nor *Trigonia* are found, but are met with in the *calcaire a Pecten lens,* an inferior member of the oolitic group.

The bed, inclosing so great a number of fish teeth, and situated, according to M. Engelhart, in the upper portion of the Keuper, is also found in the department of the Moselle, and may be observed better than in ordinary near Pange and Hombourg, on the right bank of the Moselle, between Metz and Thionville.

7. *On the Saurians of the Muschelkalk of Lorraine and Alsace, by* M. MOUGEOT.—Having directed especial attention to the study of Saurian remains, M. Herman de Meyer, by the aid of numerous materials furnished by M. Mougeot and the Museum of Natural History at Strasburg, has been enabled to establish the identity of several species, the existence of which in the Muschelkalk of the neighbourhood was unknown; and, by these means, has established a perfect identity between the Muschelkalk of the Vosges and other countries. The first of these remains is the *Simosaurus,* a new and well established genus, founded on a critical examination of a great number of teeth and fragments of the head, and nearly approaches the Nothosaurus;—the species found in this neighbourhood has been named *S. Guillardoti.* Besides this, he has discovered *Nothosaurus Andriani* and *Muensteri,* species which had only been met with in Frankonia heretofore; added to these, is a third entirely new species, named *N. Mougeottii,* and fragments of *N. mirabilis.* M. de Meyer has been fortunate enough to distinguish some traces of affinity to the Labyrinthodontes in a new species

of *Aestorrhytias* (*A. Perrini*). He does not admit the existence of turtles in the muschelkalk, and refutes the opinion of Cuvier on this point, by stating that all the portions from which that illustrious naturalist had formed his conclusions, belong to species of Nothosaurus.

8. *On the Peat formations of the eastern portion of the department of the Moselle, and especially of the environs of Bitche, by* M. H. MANDRE.—This gentleman observed that the Sphagnum not only grew in the bottoms of vallies, but also on the mountains, wherever the sand was saturated with water; he contends that turf beds are not formed by stagnant waters accumulated in vallies, as they are likewise met with on hill sides of considerable inclination; and that the reason why they are not any where found in the neighbourhood of Metz is, on account of the water being absorbed in the interlaminations of the oolite beds, and thence finding a water level, instead of rising again to the surface by imfiltration, as is the case in the Vosges Sandstone. M. H. Mandre remarked that the Sphagnum which grew on turf beds did not decay from putrefaction, and that it was only after a very considerable lapsc of time that the roots became transformed into root-mould; this, he observes, was the case with all mosses.

M. Schimper remarked that the properties of Sphagnum were peculiar; the leaves are not composed, in his opinion of two sorts of cells, but of one only, and these are of much larger dimensions than other mosses, with transverse veins, and rounded openings; and it is in this latter peculiarity that he recognizes their peculiar effect in the production of turf beds, for as several of these circular openings exist in one cell, they form a sort of sponge net-work when placed together, which is peculiarly absorbent of moisture; this capillary attraction in the Sphagnum aids the growth of Cyperaceæ and other plants which are peculiar to good turf, and continues through the whole length of the stem, so soon as its base is in contact with the water, by which means a constant irrigation is formed from below, upwards, each plant forming a system of syphons. By these means the water is continually in movement, and being frequently in contact with the atmosphere, emits azote and thus prevents the putrefaction of the mass of which the turf bed is forming.

M. Fée remarked that the lichen Cladonia raugiferina decays from time to time in its undergrowth, and continues to vegetate on the surface of the mould thus formed.

9. *Do certain plants belong exclusivelg to specific Geological formations? answered by M. Kirschleger.*

From the comparison of the flora of the Granitic Vosges and Jura our author forms three categories:—1. the plants peculiar to the Jura. 2. Those common both to the Vosges and Jura. 3. Those peculiar to the Vosges.

The number of alpine plants of the Jura (whose habitats are between 830 to 1600 metres of altitude) is 350; of the Vosges 250; 60 are peculiar to the granitic Vosges, 140 to the chalk of the Jura, 210 are found both on the Jura and the Vosges; total number of alpine plants 410, of which number the habitats of 195 are situate between 1200 and 1600 metres of altitude.

Hence it appears that the flora of the Jura is more varied than the granitic Vosges and there are plants which prefer the chalk to the granite; it does not stand to reason however, that we must hence conclude that the Jurassic plants are not found elsewhere on primitive rocks.

M. Schultz has been engaged during several years on the examination of the geographical distribution of plants in different countries; he had long believed that there are those *peculiar* to certain formations, but of late years he has determined that this cannot be admitted as a general law. It is true that in some countries the rule holds good, but in others the same plants are found in totally different formations. In the environs of Bitche for example, on a space of 43 square kilometres, on which two formations exist, the Vosges sandstone and the muschelkalk, some plants are found only on the former, some only on the latter formation: M. Schultz cited numerous examples bearing upon this point; the Anemone vernalis is peculiar to the Vosges sandstone in the neighbourhood of Bitche; at Munich and Ratisbon it is found on different formations, and chalk among the rest. It is the same with respect to the Anemone pulsatilla, which has been found on the Muschelkalk and other rocks. Amongst the plants peculiar to the Vosges sandstone at Bitche, but which are found on other mountains elsewhere, M. Schultz mentions Arabis arenosa, Sinapis cheiranthus (also on volcanic rocks), Dianthus deltoides, Trifolium alpestre, Geranium sylvaticum, Orobus niger, Rubus saxatilis, Circæa alpina, Illecebrum verticillatum (found also on the granite, &c.) Peucedanum oreselinum, Galium tenerum (a rare plant, only found at Bitche and on the plutonic mountains of the Haut Valais), G. saxatile, Hypochæris maculata, Jasione perennis, (on the granite of the Vosges and the alluvium of the plain), Myosotis sylvatica, Scrophularia vernalis, Rhinanthus angustifolius, Daphne Cneorum, Thesium intermedium, T. alpinum, Lilium martagon, Juncus capitatus, &c.

Amongst the plants of the muschelkalk of Bitche which are found elsewhere on other mountains, M. Schultz cites the following species amongst a number: Fumaria Vaillanti (clays and chalk) Erysimum orientale, Helianthemum vulgare (sandstone), Polygala calcarea, Linum tenuifolium, Trifolium ochroleucum, T. elegans, Vicia gracilis, Bupleurum falcatum, B. rotundifolium, Orlaya grandiflora, Crepis præmorsa, Lithospermum purpureo-cœruleum (porphyry and alluvium) Linaria Elatine and L. spuria, Stachys annua, Prunella alba (porphyry) Teucrium montanum, Passerina annua, Daphne mezereum, Mercurialis perennis, many species of Orchis and Ophrys, Ornithogalum sulphureum, Gagea lutea (porphyry and granite), Carex ornithopoda, Bromus erectus, Hordeum pratense; on the turf beds are found Andromeda, Scheuchzeria, Culla, Malaxis paludosa (granitic Vosges), Rhynchospora alba, Eriophorum, Carex limosus, and several species of Sphagnum. All these last named plants are found not only in turf beds, but grow on nearly all formations. Lastly, M. Schultz cites Peucedanum Chabræi and Alopecurus utriculatus as having habitats on the alluvium.

M. Mougeot denies the opinions of M. Schultz: the examples cited by him, he states are merely exceptions, but that in general there is a marked difference in the vegetation of different formations, which proves that it depends in part on the nature of the soil, and in part on their physical conditions.

M. de Caumont made several very excellent remarks as to the desirability of an agronomic chart of France, embracing that information which the joint sciences of agriculture and geology had brought to light.

For our own part we must say that the whole session displays not only talent, but, what is as essential to the proper application of the opinions elicited, a system of management and conduct which it would be well to introduce into larger bodies in this country or elsewhere. We find the essays ranged in systematic order, the debates tending directly to the point, and hence we have a progression through the range of the sciences of geology, botany, and agriculture, in their reciprocal relations. The whole is a valuable addition to a knowledge of the natural history of the district of Alsace.—C. M.

MEMOIRS.

Lithology—or Observations on Stone used for Building—by C. H. SMITH, ESQ.

Whoever has travelled extensively in Great Britain for the purpose of examining Architectural Works of the present and past ages, cannot be otherwise than surprized at the remarkable difference in the condition and durability of stone. Many beautiful buildings of recent date are in a worse state of external decay, than some which have borne vicissitudes of summer and winter during six and seven centuries. To discover the causes of such decay, and the means of avoiding the evil in future, may appear to be an investigation of some difficulty, especially if we consider the immense variety of stones used for building in this country, each composed of various elementary substances, and in very different proportional quantities; yet although we may not arrive at a perfect knowledge of the facts, some advantages may be derived from the attempt, such as suggesting enquiries, and giving interest to an important and heretofore unexplored subject, or generalizing and arranging sound practical observations so as to induce others to take it up. Thus, by a series of well directed experiments forwarded upon extensive research amidst old buildings, certain conclusions may probably be inferred, which may ultimately be established on what approaches scientific evidence.

In a long period the most refined taste in elegant architecture was extensively practised throughout this country upon scientific principles, which, if ever equalled, have assuredly never been surpassed; yet the quality of the stone employed seems rarely to have been considered further than for the facility with which it might be wrought by workmen.

Relics of long departed grandeur abound in most parts of the kingdom; nearly all the beautiful works of our ancestors are constructed with stone from the immediate neighbourhood of such buildings, apparently without any regard to colour, strata, or durability, and hence we frequently see stones of very different tints indiscriminately placed together in the same elevation, some extremely perfect, others in a very mouldering condition, as in the cases of Whitby Abbey, Bristol Cathedral and King's College Chapel at Cambridge.

We will now give the substance of Mr. Smith's remarks on the various kinds of stone, as the essay itself is in many portions foreign to our subject, and too lengthy for insertion in a complete form. *Caen Stone* was used very considerably for ornamental architecture in the South of England, from the Conquest to the time of Henry VIII; it does not seem to possess advantages over various stones of the same character, the produce of our own country; many qualities are found in the same district, and even in the same quarry, of variable durability. The central Tower of Canterbury Cathedral, St. George's Chapel at Windsor and Henry VII. Chapel at Westminster, are all built of this, about the same time (between 1472 and 1517,) yet the Tower of Canterbury is in much better preservation than most structures of the same date, and St. George's Chapel is by no means so much dilapidated as that at Westminster, which was restored between 1808 and 1822.

Mr. Smith is of opinion that so much difference in durability, arises much more from the different qualities of the same description of stone than from local circumstances.

When political disputes probably gave rise to the prohibition of importing Caen Stone, the rocks nearest the metropolis afforded the material for building, and hence *Riegate Stone, Gatton Stone, Merstham Stone* were employed, but there is hardly an instance where, having been exposed for twenty or thirty years, the surface has not mouldered into thin flakes; the greater part of Westminster Abbey was formerly built of Godstone Stone.

During this same period *Kentish Rag* (a hard grey limestone) was brought from the neighbourhood of Maidstone, and employed for ruder purposes; the basement of Henry VII. Chapel is of this material; about this time (A.D. 1600,) Portland became the general stone used for superior buildings in London, and the South of England. Inigo Jones having been deputed by James I. to survey the crown lands at Portland led to its introduction; at first all that was obtained came from thence (the locality of these lands being on the North East of the Island), but as the demand increased large quantities were brought from the West and South East Cliffs, without the slightest regard to durability, quality, or any other consideration of fitness than that of meeting with an immediate sale.

Portland Stone of the most durable quality is comparatively heavy, of an uniform colour, rather dark, (owing to the quantity of cement,) of a crystalline texture, regularly dispersed throughout the pores, and hence it will resist a greater force to crush it, or to disintegrate the particles. The following comparison will show the relative peculiarities of good and bad Portland stone, considering the specimens, when examined, subject in every respect to the same conditions, such as being equally wet or dry, &c.

Good.	Bad.
Preponderance of weight	Deficiency of weight
Dark coloured	Light coloured
Uniform colour	Party coloured
Compact and Crystalline	Open and powdery
Hard to crush	Friable

Glass veins as they are technically termed are no defect, they only cause the surface to wear irregularly, and when all other parts became colored with lichens or dirt, remain completely white. According to the report of Professors Daniel and Wheat stone, appended to the report on the selection of stone for building the new Houses of Parliament, the following inference may be drawn, *that in all stones of the same class, the heaveist kind, or that which has the greatest specific gravity, is the most durable and best suited for architectural works.* This is given as a general rule, although liable to some exceptions, but it appears to hold good with all varieties of Portland stone.

The beds of Portland stone are very different in quality, the most perfect being that which is situated about midway in the series. The stratification varies in thickness from north to south; this is very conspicuous in the Way-croft quarries, where the top bed is double the thickness of the corresponding bed in the Grove quarries; the former is perhaps the best stone in the island, whereas the latter is so corse and inferior that it is rarely or never used.

With respect to the sandstones generally it is essential to remark that as laminated strata, blocks cut from them must partake of their nature, and consequently, if placed in an exposed situation with the planes of lamination parallel to the outward surface of the building, it will exfoliate or decompose in flakes, according to the thickness of the laminæ, whereas if the same stone were placed so that the plane of lamination be horizontal, that is most commonly upon its natural bed, the amount of decomposition will be comparatively immaterial.

Some of the sandstones are iregularly laminated, presenting an appearance across the strata of a number of short black lines, arising from small quantities of carbonaceous matter being interpersed in beds, often parallel to each other, as in Craigleath bed rock, but occasionally as if formed by a succession of minute undulations, similar to rippled markings of agitated shallow water upon sand. The stone from Garscube or President quarry, near Glasgow, is of this description.

Many sandstones are composed of small pebbles varying considerably in appearance, and often differing essentially in their elementary character. These are coarsely conglomorated together so as to form a sort of pudding stone or indurated gravel, of which Bramley Fall, especially the coarse grained variety, is a good example; if these various substances be exposed to the same causes of decomposition, they will resist them unequally, those parts of the stone which decompose most readily being removed, leave the durable portions exposed, so as to be more easily affected by mechanical forces, such as the freezing and expanding of water after being absorbed by the pores of the stone, occasioning a disruption of the external particles; a constant succession of these chemical and mechanical operations, will disintegrate a mass of stone, composed of various substances, in much less time than if the same bulk were formed of one uniform homogenous material, if that one material even were the most decomposable portion of the conglomerate to which allusion has just been made.

After having examined the component parts of a stone, the next consideration must be the condition of those parts to form the aggregate; in all specimens of genuine sandstone, the grains are infinitely more durable than the cement which unites them, and in some cases, notwithstanding the cement is of the best quality it may be so scantily supplied, that the grains are scarcely attached to each other, consequently such stone must be extremely friable, and will suffer from all kinds of mechanical forces. The great portion of the mass of all sandstone is made up of quartzy or siliceous grains, if the substance that cements the grains together be also siliceous the stone will most probably be very durable; but we frequently find siliceous grains cemented with argillaceous, calcareous, ferruginous or other matters, each of which has more or less affinity for the Silica, and of course the grains are more or less attached to each other. Those cements which partake most of the character of iron or clay, are most likely to separate from the grains of quartz; consequently, a sandstone thus composed, will, in all probability, soon yield to atmospheric influences, because the oxygen of the atmosphere produces considerable alteration in stone containing much iron, under which circumstance it is generally reduced from a hard state to a soft and crumbling substance; if the component parts of a stone be siliceous, with a calcareous cement, there is good reason to believe that such a substance will stand the weather tolerably well, for it may be considered the natural product, of which human ingenuity has, from a very remote period, successfully formed an imitation in the commonest of all building materials, mortar.

A defect to which all sandstones are liable is, that a portion of uncrystallized, carbonaceous, ochreous or earthy powder, sometimes nearly fills the interstices between the crystals, forming occasionally what are called "clay balls," and often lying between the laminations. These are always injurious to the durability of a stone, especially if they amount to any considerable quantity.

It may be remarked with respect to sandstones generally that there is seldom any difference between the numerous beds, as regards their qualities of withstanding weather; this is instanced in the Duke of Devonshire's quarries on the river Derwent, in those near Leeds, Huddersfield, Dundee, Edinburgh and Glasgow, in some of these cases being a range of two hundred feet.

The greatest objection to sandstones in an economic point of view, is the difficulty with which they are applicable to decorative purposes, and the expense of sawing.

The *Craigleith stone,* which deserves to be classed amongst the best of sandstones, costs nearly four times as much to saw as Portland stone.

It is important in many respects whether the component parts of sandstone be fine or coarse. Some kinds are composed of such large particles, as to be distinctly visible to the naked eye at several feet distance. The coarsest of *Bramley Fall,* and of other *mill-stone grits* from the vicinity of Leeds, are examples of this description: others are, on the contrary, so finely grained that a microscope is required to distinguish their structure—the former would be the first to decompose in consequence; for example, among the numerous sandstone buildings in this country, those which have been constructed with a fine grained stone are usually in the best state of preservation; and it may generally be considered as a sort of rule, that the same description of work can be performed in less time if the stone be fine-grained than if it be coarse.

Particular cases may come under an architect's consideration, wherein the specific gravity of stone is of serious importance, such as landing steps occasionally under water, where there may be a rapid current, or in other situations, subject to the influence of powerful waves, especially of sea-water, such circumstances will require that a heavy stone should be used, because all bodies immerged are reduced in weight precisely equal to that of the bulk of water which they displace. The lightest stone I have ever found is from Gatton, in Surrey, weighing 103lbs. to the cubic foot; now, if a similar stone were used in water, it would be reduced sixty-three pounds (the weight of a cubic foot of water); therefore it would be like building on land with a material weighing only forty pounds to the foot. The heaviest building stones that have yet come under my notice are the *dark grey varieties of sandstone from the vicinity of Swansea, Glamorganshire; Abercarne, Monmouthshire; the Forest of Dean, Gloucestershire, and the neighbourhood of Dundee*; some of which are even heavier than granite and quite as durable, weighing upwards of one hundred and seventy pounds per cubic foot. Hence it will be perceived that such stones are peculiarly adapted for docks, harbours, breakwaters to bridges, &c. In situations constantly or alternately under sea-water, sandstone is preferable to limestone, because it is not so liable to be perforated by *Saxicava rugosa, Pholas,* or other boring mollusca, which frequently honeycomb calcareous stones within their reach, to the depth of several inches.

Granite ranks amongst the oldest formations; it may be considered good and durable in proportion to the fineness of the component parts, and especially in proportion to the abundance of quartz and scarcity of felspar. In Cornwall and part of Devonshire, the granite is remarkable for the superabundance of well defined and large crystals of white felspar which it contains, and it is from this cause, that it is less durable than the granite of Aberdeen or Guernsey, in which quartz and mica preponderate greatly.

The quality under all circumstances improves in proportion to the depth from which it is quarried.—*Abridged from the "Transactions of the Institute of British Architects."*

On the Geology of the United States. *By* CHARLES MOXON.

Europe has, since the geological era, been so continually the subject of geological research, that we are comparatively well versed already in its details, generally speaking, whilst the comparison has extended only to a very small distance beyond its bounds—we have therefore trodden out of the beaten course, in fulfilling the promise which we held out of a series of essays on local geology, and have selected America as the first object of remark, not only on account of the growing interest which geology is acquiring within its boundaries, through the medium of the most able members of the "American Association of Geologists and Naturalists," but because it is peculiarly interesting also in an economic point of view, both to the geological and commercial classes of the community. As yet, however, the researches into the minute details have not extended sufficiently far to enable us to present a general map of the exact geological structure of this region, such as we already possess with reference to most of the kingdoms comprised in Europe; in fact, although the geology of some of the states is accurately known, the greater portion have only been so far investigated, that an outline map of the distribution of the general class of strata is all that can be attempted with any degree of fidelity; but in this we have no cause for complaint, as, when geological research shall have laid down more accurate data for the construction of charts, with exactitude, a reference to those which we now publish, and such as will be found in future years in our pages, as an evidence of investigation and research, will prove the progress of geology in the intermediate period, and, also, the value of the records contained from time to time in our pages. We find that little was effected in the study of the geology of the United States before the year 1817, when Mr. Maclure submitted an interesting essay on the subject to the American Philosophical Society, the exactitude of which has been proved by subsequent researches, and which may, therefore, be said to form an excellent foundation for the study of American geology.

The peculiar structure of the continent of North America by the extended continuity of the immense masses of rocks of the same formation or class, with the uniform structure and regularity of their uninterrupted stratification, forces the observer's attention to the limits which separate the great and principal classes; on the tracing of which he finds so much order and regularity that the collection of the *facts* present somewhat the delusion of theory.

The prominent feature of the eastern side of the North American continent, is an extended range of mountains running nearly north-east and south-west, from the St. Lawrence to the Mississippi, the most elevated parts as well as the greatest mass of which consists of *primitive* as far south as the Hudson River, decreasing in height and breadth as it traverses the state of New Jersey. The primitive occupies but a small part of the lower country, where it passes through the states of Pennsylvania and Maryland, where the highest part of the range of mountains to the west consists of transition, with some intervening vallies of secondary. In Virginia the primitive increases in breadth, and proportionally in height, occupying the greatest mass, as well as the most elevated points of the range of mountains in the States of North Carolina and Georgia, where it takes a more westerly direction.

Though this primitive formation contains all the variety of primitive rocks found in the mountains of Europe, yet neither their relative situation in the order of succession, or their relative heights in the range of mountains, corresponds with what has been observed in Europe. The order of succession from the clay slate to the granite, as well as the gradual diminishing height of the strata, from the granite through the gneiss, mica slate, hornblende rocks, down to the clay-slate, is so often inverted and mixed, as to render the arrangement of any regular series impracticable.

No secondary limestone has been found on the south-east side of the primitive, nor any series of other secondary rocks, except some partial beds of the old red sandstone formation, which partly cover its lower edge; in this it seems to resemble some of the European chains, such as the Carpathian, Bohemian, Saxon, Tyrolean and Swiss mountains; all of which, though covered with very extensive secondary limestone formations on their north and west flanks, have little secondary on their southern and eastern sides. The old red sandstone above mentioned, covers partially the lower levels of the primitive, from twelve miles south of Connecticut river to near the Rappahannock, a range of nearly four hundred miles; and though often interrupted, yet retains through the whole distance, the uniform feature of resemblance so remarkable in the other formations of this continent. The same nature of sandstone strata is observable, running nearly in the same direction, partially covered with wacke and greenstone trap, and containing the same metallic substances. The uniformity is equally observable in the great alluvial formation, which covers the south-east edge of the primitive, from Lay Island to the Gulf of Mexico, consisting of sand, gravel, &c., with silt, both of marine and lacustrine or river origin, containing both vegetable and animal remains, found from thirty to forty feet below the surface.

Along the north-west edge of the primitive commences the *transition* formation, occupying, after the primitive, some of the highest mountains in the range, and appears to be both higher and wider to the west in the states of Pennsylvania, Maryland, and part of Virginia, where the primitive is least extended and lowest in height. It contains all the varieties of rocks found in the same formation in Europe, as the mountains in the Crimea &c. and resembles in this the chain of the Carpathian, Bohemian and Saxon mountains, which have all a very considerable transition formation, succeeding the secondary limestone on their northern sides. Anthracite has been found in different places within the range of this formation, and has not yet been discovered in any of the other formations in North America, a fact alluded to by Mr. Maclure, but which still holds good in the present advanced state of the science. On the north-west side of the transition formations, along the whole range of mountains, lays the great *secondary* formation, which, for the extent of surface it covers, and the uniformity of its deposition, is equal in magnitude and importance, if not superior to, any yet known; there is no doubt of its extending to the borders of the great lakes to the north, and some hundred miles beyond the Mississippi to the west. From the investigations already made it seems clear, indeed, that the western limits of this great formation cannot be far from the Stony mountains, and to the north, that it reaches beyond Lake Superior, giving an area extending from east to west from Fort Ann, near Lake Champlain, to near the foot of the Stony mountains, of about fifteen hundred miles, and from north to south from the Natchez to the upper side of the great lakes, about twelve hundred miles. The continuity of this formation is nowhere interrupted, on the east side of the Mississippi, by the intrusion of older rocks, the only variation being the existence of tertiary districts along the banks of the large rivers. The foundation of most of the level countries is generally limestone, and the hills and ridges in some places consist of sandstone—a kind of dark coloured slaty clay, containing vegetable impressions with a little mixture of carbon, frequently alternates with all the strata of this formation, the whole of which are nearly horizontal. The highest mountains are on the external borders of the basin, gradually diminishing in height towards its centre.

Two divisions of the secondary formation common in Europe have not been discovered in this; the chalk formations, and what Werner calls the "floetz trap," formation. The limestone found in this basin is of a bluish colour running through all the shades to a dingy black, having an even, rather earthy fracture, and sometimes a schistose structure. The flints found in the secondary limestone in America are generally black, resembling the Lydian stone, and in all kinds of irregular forms and branches, intimately mixed with the limestone. The limestone, which often follows the chalk in countries when the latter formation occurs, is generally of a white, running into a drab or light brown colour, a smooth, compact, conchoidal, (almost resembling the flinty) structure, having in some parts of the stratum rounded nodules of flint, interspersed apparently without order; the flints in some places dark-coloured, in others light; and some of the nodules whitish on the outer edge, and blackish towards the centre.

A very extensive and regular formation of the above-mentioned kind of limestone succeeds the chalk in Europe, and covers the transition formation on the north side of the mountains of the Crimea; holds the same relative situation along the north side of the transition on the Carpathian mountains; continuing through Silesia and Bavaria along the Bohemian mountains to Ratisbon; from thence up the Danube to Schaffhausen on the Rhine; and follows the north-west side of the Jura, across the Rhone, to the Mediterranean; the limestone, during this long course, is similar both in colour and structure, and in some places on the banks of the Danube, is in a schistose form.

The absence of the newest floetz-trap formation (which partially and irregularly covers all other formations, thereby breaking the continuity of the strata), as well as the effect of the violent convulsions and earthquakes so frequent in the vicinity of this disputed formation, may be one cause why the prosecution of geological research is so much more easy in North America than in Europe. A second cause, producing much more universal and extensive effects, may perhaps be found in the difference of the number and magnitude of the accidents and changes that have been effected in the stratification of the various classes of rocks on the European continent, since their original formation, by the effects of water washing away the more perishable superincumbent strata, and leaving the more hard and durable parts of the same stratifications in their original positions, or by the long and continual action of rivers, wearing deep beds, and exposing to view the subordinate strata, giving to the whole the present appearance of confused and interrupted masses, though they might have been extremely regular in their original state.

A third cause of the facility of geological investigation in North America, may arise from the whole continent east of the Mississippi, following the arrangement of one great chain of mountains; a fact which, simple in itself, bears out the real utility of studying the physical in its relation to the geological structure of any district, and as affording evidence of a rule, very general in its application, and very little liable to exceptions. This chain of mountains, the axis, we may so term it, of the geological structure of the United States, commences at the St. Lawrence river, and appears to be a spur from the great mass of primitive, which occupies all the northern parts of the continent, runs in a south-westerly direction to the borders of Florida, is covered by the alluvial, and bounded by the sea on the east side, on the west side it is covered by the considerable transition formation, which is followed by a still more extensive secondary formation all of which run in a regular line of continuity. Europe, on the contrary, is formed of five or six chains of mountains, all following different *lines* of stratification, and frequently interrupting each other; which increases the difficulty of arranging them in groups, and augments the apparent confusion.

The difference between the ranges of mountains in Europe and North America appears to be much greater as respects the accidental and subsequent changes, than in the original order and arrangement of their stratification, in the relative situation whereof they frequently agree. On the edge of the secondary, not far distant from the transition, have been found the most productive salt-springs yet discovered in North America, running nearly north-east from Pigeon's river in the State of Tennessee, to lake Onondaga: and in the same direction of the stratification, gypsum has been discovered. This situation of salt and gypsum corresponds with that of the salt mines of Cracow in Poland, which, with some others in the same country, are found on the edge of the secondary, almost touching the great transition formation, which covers the north side of the Carpathian mountains.

The country round the Baltic, bounded by a line running easterly to the Hartz, through Silesia, along the Carpathian mountains to the Crimea, and north by St. Petersburgh, including Denmark, part of Russia, Prussia, Poland, Finland, Sweden and Norway, is similar to the east side of the river Missippi in North America, inasmuch as it contains little or none of the basalt or newest floetz-trap formations, and very few warm springs, in proportion to the extent of surface, have yet been found in the countries above-mentioned, though on the south side of that line in Hungary and Bohemia, the floetz trap formation and hot springs are frequent; and in crossing the Stony mountains in North America, on the western side of that continent, between the sources of the Missouri and Columbia rivers, two very hot-springs were found by Capt. Lewis, and the same mountains likewise contain rocks of the newest floetz-trap formation.

Since the date when Mr. Maclure submitted the interesting account alluded to, and from which we have borrowed largely, but little has been done to enable the geologist to lay down an accurate chart of the distribution of the various formations; the investigations which have been conducted, are generally too cursory, and treat too largely upon the posterior disturbances and intrusion of igneous rocks (a very favourite subject now-a-days); and perhaps this may be excused, upon the ground that the area of geological research in the American continent is so large and extended that it were vain to grapple with the whole subject ere the minutiæ affecting the general continuity were determined. It is on the ground then, that it is as yet impossible for us to give any other than a chart exhibiting the distribution of the general classes of rocks.

To the east of Hudson's river, the primitive class prevails, bounded on the side of the ocean by vast tracts of alluvial formation which skirt the granite ridge. To the westward of the State of New York, the stratification runs nearly north and south, and generally dips to the east, looking up to the white hills, the most elevated ground. In New York State, and to the westward, the stratification runs nearly north-east and south-west, and still dips to the east. All the rivers east of the Delaware run nearly north and south, following the stratification, while southern rivers incline to the south-east and north-west direction.

Throughout the greatest portions of the eastern and northern states, the sea washes the foot of the primitive rock; the deposition of an extensive alluvial formation commences at Long Island, increasing in breadth to the south, forming a great part of both the Carolinas and Georgia, and almost the whole of the two Floridas and Lower Louisiana.

That no volcanic productions have yet been found east of the Mississippi, is not the least of the many prominent features of the Geology of America.

[For map see frontispiece.]

On Drifted Remains found in Gravel, near Radwell, Herts.

By W. Stocken, *Esq.*

The remains in question are found in a stratum of gravel, about four feet under the surface, at Radwell, a small village in Hertfordshire, about two miles north of Baldock, and about a quarter of a mile from the Beds marl-bed. The bed of gravel itself is of very slight thickness, reposing upon a bottom of chalk about 5½ or 6 feet from the surface. The remains found in it are very limited also as to variety, but abundant in quantity those, perhaps, in my possession are about the finest which have been met with, and are sufficiently perfect to enable me to judge of the specific characters. The first (Fig. 3.) is a portion of *Ammonites perarmatus,* consisting of seven sectional plates, each of which, when detached, presents the appearance of lobes and saddles, as described by D'Orbigny in Geologist, vol. i. p. 100. This species appears to be predominant, although the examination of several smaller specimens would almost lead us to the supposition that they belonged to individuals of *A. obtusus.* These specimens generally consist of from five to seven sectional plates, each averaging in size 4 inches in length, 1¼ inch in lateral breadth, and about ½ an inch in thickness.

The specimens figured in plate 2, are of a hard calcareous crystalline substance, many of them circular in form and others closely resembling fig. 1 in this plate; associated with these are large masses of septaria, the calcareous divisions in which bear

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FIG. 3.

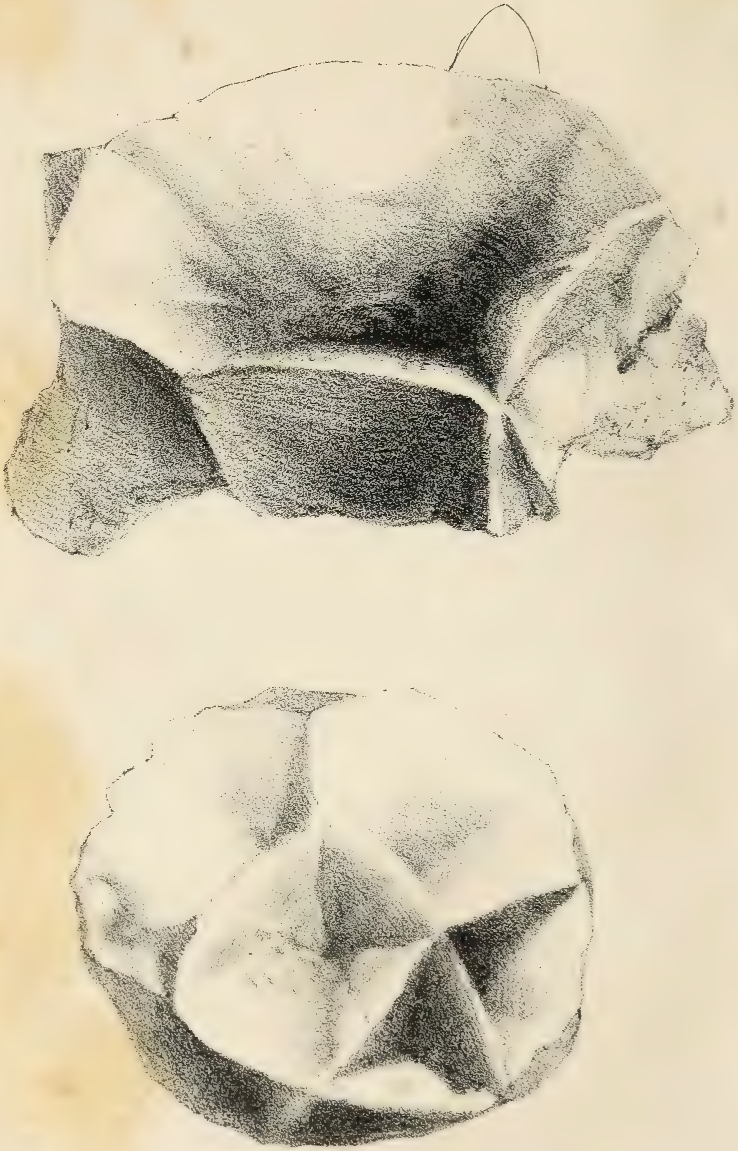
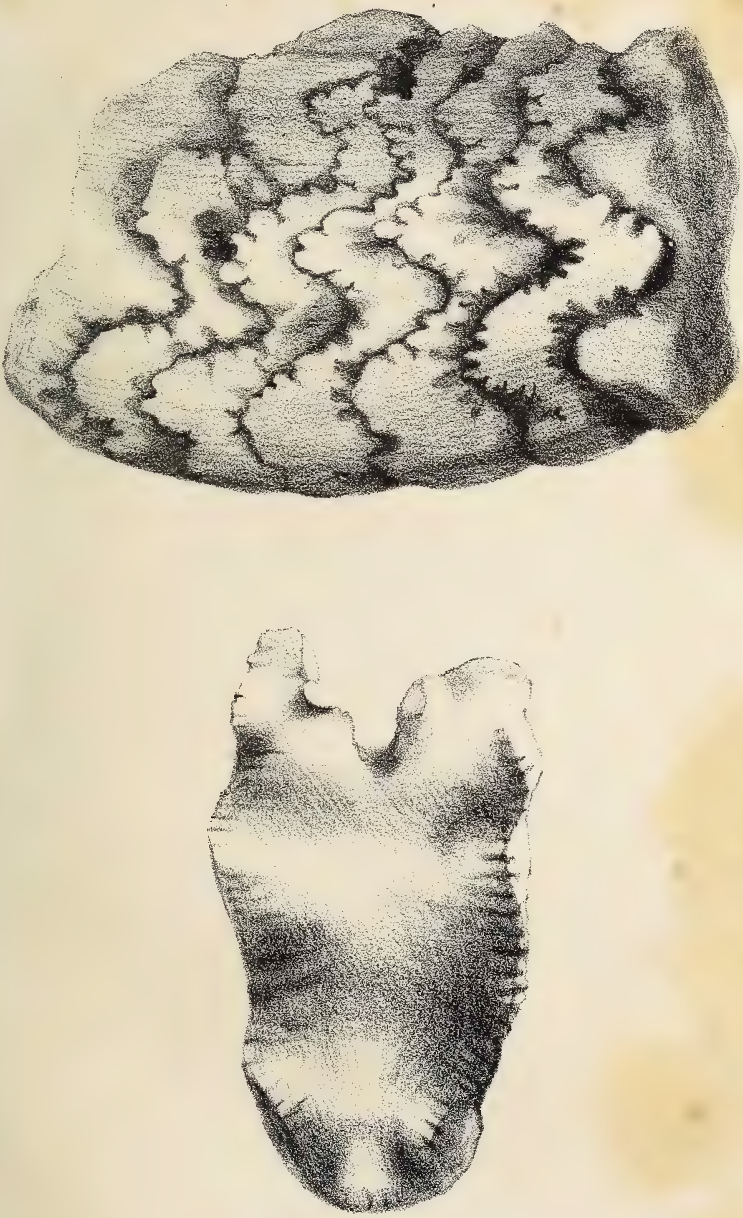


FIG 2.



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the same appearance as that of the specimens we have just described, the cells are not always filled with clay, in many cases they are partially or quite empty, and therefore we have no difficulty in tracing the affinity between them.

The question of interest connected with these remains is that of their origin. The labours of the geologist having traced the occurrence or absence of particular species in or from particular strata, we are now led from the discernment of the species to the identification of their parent bed. The ammonites perarmatus is essensially oolitic: the A. obtusus, on the contrary, liassic, whilst the septaria which accompanies them is abundant in the Kimmeridge clay of the district to the north-east of Radwell. This diversity of origin, perplexing as it might appear at first sight, is the better means placed at our disposal, for the solution of the question before us. The drift must have occurred from the *north*—the remains of ammonites in this drifted gravel are identical with those of the Yorkshire oolite and lias, and the locality of the septaria we have before stated to be equally clear—added to these the general direction of the diluvium in this district is a further proof of the correctness of our supposition.

MISCELLANEA.

New Fossil Crustacea. The *Pemphyx Sueurrii* has been found in Horgen. *Glyphea regleyana* in the coral rag of the Saône; *G. Munsteri (rostrata), G. Dressierrii,* in the same; *G. pustulosa* in the oolite of Ohringen; *G. liasina* in the lias of Menzingen; *G. grandis* in the lias of Frittlingen; *Clytia ventrosa* in the coral rag of the Saône; *C. Mandelslohii* in the schist of Dettingen; *Prosopon tubeosrum* in the Strasburg oolite; *P. hebes* in the clay of Mossel; *P. simplex* in the clay of Streitberg; *P. rostratum* in the clay of Kelheim.—*Neues Jahrbuch.*

Fossils in the Lithographic slate of Bavaria.—Pterodactylus Meyeri (near Kelheim); *Scrobodus ovatus* (near Solenhofen) *Cœlacanthus* (at Kelheim and Eichstadt); *Thaumas; Aethalion angustus; Aet. angustissimus; Aet. inflatus; Aet. Tenuis; Aet. subovatus; Aet. parvus; Pachycormus gibbosus; P. striatissimus; P. latus; P. elongatus; Pholidophorus angustus; Caturus granulatus; C. obovatus; C. intermedius; Aspidorhyncus longissimus; Belonostomus angustus; Gryrodus meandrinus; Libys polypterus.* Besides these remains of fishes and reptiles, Count Münster relates that he has received specimens of crabs, insects, sepia and plants.—*Idem.*

Remains of the Elasmotherium.—M. de Keyserling has discovered at Surico (on the borders of the Caspian sea) a tooth of the Elasmotherium; an animal which appears to have been one of the class pachydermata, and more nearly resembling the elephant than any other animal; but as this tooth indicates some relation between the Elasmotherium and the Rhinoceros, M. de Keyserling concludes, that it served as a connection between the rhinoceros and the elephant. M. Fisher has compared it with the structure of that of the *Elasmotherium Sibiricum* (discovered in 1808), and finds it quite distinct; hence he has named the species *E. Keyserlingii,* and is therefore the second of the genus. *Echo du monde savant* 13, *Sept.* 1842.

On the composition of the Asbestos from Scharzenstein (Zillerthal.).—This variety is characterized by length of fibre and its great whiteness. M. Meitzendorf has found that 100 parts contain:—

		oxygen.	
Silicic acid	55,869	20,023	
Magnesia	20,334	7,870	14,090
Chalk	17,764	4,989	
Prot-oxide of Iron	4,309	0,981	
Prot-oxide of Manganese	1,115	0,250	
	99,391		

As the silicic acid contains nearly twice as much oxygen as the aggregate of the bases, we have the result in the following formula.

$$\left.\begin{array}{l}\cdot\mathrm{Mg}^3\\ \cdot\mathrm{Ca}^3\\ \cdot\mathrm{Fe}^3\\ \cdot\mathrm{Mn}^3\end{array}\right\}\ \cdot\ \dddot{\mathrm{Si}}^2$$

This asbestos has then the same composition as pure augite, if we except the alumina, whilst the asbestos of Tarantaise, analyzed by M. Bousdorf partakes of the composition of Hornblend, which, in reality, does not differ much from the former. It appears therefore that asbestos is not a simple mineral, but only a form under which many present themselves.—*Annalen der Physick.*

The application of M. Venetz's hypothesis to the erratic phenomena of the North.—by M. DE CHARPENTIER.

The last catastrophe which affected the northern hemisphere on any scale of importance, changed the climate to more cold and wet than it had partaken of before or since; this temperature was insufficient to melt completely the snows which existed to the N. of 60° parallel of North latitude. The snows comprised between the 60° and 70° were transformed into glaciers, and above that they remained frozen. This glacier having accumulated to a considerable size, overwhelmed the north of Russia to Moscow, Prussia, Poland, the north of Germany, and perhaps even the eastern coasts of England.

By these means the erratic deposits were transported and deposited, and to this may be attributed the abrasion, aud groovings which are observed on the surface of the rocks.

The ösars are moraines, formed in part by the *variations* experienced by the principal glacier in its retreat, and in part by the ice which remained on the summits long after the lowlands had become freed from snow.

The materials of which the diluvium is composed, both within and beyond the limits of erratic phenomena, were transported by rivers and submarine currents; the greatest masses of diluvium were deposited during the thaw and retreat of glaciers.

Erratic blocks which we find comparatively isolated or buried in diluvium, and beyond the limit of erratic phenomena, were transported on detached masses of ice, some of which were carried downwards by the currents of rivers, and others, floating on the sea, were driven southwards by the winds.—*Bibliotheque universelle de Geneve.—June* 1842.

The double arrangement of molecules—The difference in the crystallization of any substance generally arises from a difference in its constituent elements, which have a particular and distinct influence on the crystallizations. Iron crystallizes in cubes and octahedra, whilst peroxide of iron crystallizes in rhomboids with angles of 85° 58′ and 115° 71′. Thus 2 atoms of iron, in combining with 2 atoms of oxygen, lose the cubic form and are transformed into rhomboids of determinate angles. Crystals of arsenic are rhomboids of 85°. 26′ and 114° 26′, those of arsenic acid are octahedra and sometimes prisms; from this it results that the crystals of iron and arsenious acid are identical; it is the same with respect to those of peroxide of iron and arsenic. The intervention of oxygen in the crystallization appears to be constant, as one finds 3 atoms of oxygen combining with 2 atoms of iron to form the same crystal as arsenious acid when deprived of 3 atoms of oxygen, that is to say reduced to its metallic state. Cubes of metallic iron become rhomboids when the metal takes the form of peroxide, in the same way that rhomboids of metallic arsenic become cubes, when it assumes the form of a deutoxide.—*Poggendorf's Annalen,* 3, 1842.

On the Evolution of Oxygen from the Organic Deposit of a Salt Spring.—At the bottom of the salt basins of the salt works of Rodenberg, in Hessia, a glutinous mass is formed, of a greyish-yellow colour, and of a tough, slimy appearance, not unlike semi-decomposed animal membrane. Even after being washed, it preserves an odour of fish or sea-water. This substance is every where filled with large bubbles of air, sometimes of several inches in breadth, which are so tightly enclosed in the substance that they cannot escape therefrom of themselves, but ascend to the surface in great number, as soon as the slimy surface is torn by means of a stick. The quantity of air thus enclosed is so considerable, that hundreds of bottles might be filled with it. If a burning chip be brought into this air, it inflames, and burns with a bright flame. The air consists of 51 per cent. of oxygen gas, and 49 per cent. of azote. Wöhler is of opinion, that at first pure oxygen is evolved, which, however, like air in an animal bladder, is partly exchanged for atmospheric air. It must be observed, that the salt water, when recently pumped out, contains such a quantity of sulphuretted hydrogen, that it might be taken for sulphuretted water: having, however, once passed through the thorn walls, or filters, into the salt basins, it entirely loses its odour. It was ascertained by microscopic observation, that the membranous mass consisted of living and moving infusoria—species of Navicula and Galionella being interwoven with extremely delicate and colourless threads of confervæ. Since, according to the supposition of Ehrenberg, Priestleyan green matter is not a vegetable substance, but consists of real animalculæ, especially Chlamidomonas *Pulvisculus,* and Englenæ *viridis,* which likewise exhale 60 per cent. of oxygen, the evolution of the before-mentioned gas cannot be ascribed to the confervæ existing in the mass, but rather to the infusoria, and to these latter alone.—F. WÖHLER, *Poggendorf's Annalen.*

To separate Silver or Gold from Lead.—Take a few grains of bone ash, make it into a paste with a little saliva, spread it about one line thick on a piece of charcoal, and make a shallow impression in it, to receive the globule of metal. Expose it to the heat of the blow-pipe, so as to burn it white and hard, and then melt the globule of the alloy on it, and keep it in a constant red heat, till the lead is all oxidised. The advantages of the bone ash over the mica sometimes employed are manifold. 1. It is easier to be obtained, and everywhere the operator can prepare a little if he should not be supplied with it. 2. The metal will remain in the concavity of the bone ash paste, and not be liable to run down and be lost, as on the mica. 3. It is never necessary to change the material; the bone ash absorbs the litharge which collects on the mica, and impedes the process, so that the remaining metallic globule has to be transferred to a fresh slip of mica. 4. The colour of the paste, after the operation is finished, gives an indication as to the nature of some impurities of the metal; lead alone makes it appear yellow; a small proportion of copper changes the yellow colour to greenish.—*Dr. G. Engellmann.*

Manufacture of Sulphuric Acid from Gypsum.—Thaulow has proposed the following method for preparing sulphuric acid in large quantities from gypsum. The gypsum is reduced in iron or earthern retorts by heating with charcoal; the carbonic acid which is evolved is not suffered to be lost, but is preserved for further use. The sulphuret of lime is mixed with some water and the carbonic aoid gas passed into it; the sulphuretted hydrogen which evolves is conducted into leaden chambers, and there first burnt to water and sulphurous acid, and this latter oxidised in the usual way.—*Archiv. de Pharm.*

Ox-Acids of Sulphur.—Specimens of a new ox-acid of sulphur were submitted to the Paris Academy of Sciences; this acid, having for its formula $S^4 O^3$, has been named by the discoverers MM. Fordos and Gelis, bisulphuretted hyposulphuric acid. It completes, according to them, a curious series of the ox-acids of sulphur, the quantity of oxygen remaining constant, whilst that of sulphur increases according to the numbers 2, 3, 4, thus :—Sulphuric acid, $O^3 S^2$; sulphuretted hyposulphuric acid. $O^3 S^3$; bisulphuretted hyposulphuric acid, $O^3 S^4$. MM. Fordos and Gelis have succeeded in isolating their new acid, as also some of its principal compounds. The following are some of its properties:—It is but slightly more changeable than the hyposulphuric acid. It is colourless and transparent; and, if it be boiled, it is decomposed into sulphur and sulphuric acid. Free or combined, it is not altered by the muriatic and sulphuric acids—nitric acid, on the contrary, throws down sulphur.—*Mining Journal.*

Separation of Lead from Bismuth.—Ullgren precipitates the oxides with carbonates of ammonia, and dissolves them in acetic acid; a strip of clean lead, the weight of which is known, is then put into this solution, so that the whole of it is covered. The vessel is closed and allowed to stand for two hours. Bismuth is separated in a metallic state, that which remains on the lead is washed off, and the strip dried and weighed. The bismuth is brought into a filter and washed with water which has been allowed to cool; it is then dissolved in nitric acid, evaporated, heated, and the oxide of bismuth weighed. The solution of lead is precipitated with carbonate of ammonia, and the oxide determined. The loss of weight which the lead suffered gives the quantity of oxide of lead which was not originally in the solution.—*Idem.*

Fossil Remains.—A large collection of the fossil remains of antidiluvian animals has been found in a grotto at Fauvent le Bas, in the Haute Marne. They comprise the jawbones of the hyena, tiger, panther, and buffalo, some very large sized stag horns, and also some bones of a species of bear, which, according to Cuvier, is no longer in existence.

Organic Remains. A quantity of bones of the bear, hyena, hippopotamus, rhinoceros, deer and elephant, have been discovered in a cave in the mountain limestone at Durdham Down, Bristol, and the peculiarity of the circumstance is, that they were found in a fissure only, whch, as far as can be ascertained, extends a very considerable depth lower than the workmen have ever yet gone. This is not the case in other places, where the bones are all found in caverns, which would appear in some measure to refute the theory of certain philosophers, viz. that these caverns were the resort of the hyena or tiger, where they dragged in and devoured their prey, and afterwards died in the same cave; these bones agree in character with thsse from the celebrated bone caves of Banwell, Hutton and Uphill on the Mendip Hills.

REVIEWS.

LOCAL GEOLOGY.

Our Triangle.—Cheltenham, Rawlings and Lake, 1842.

An anonymous author has presented to the public under the above title, a series of letters collected from the pages of the Cheltenham Chronicle, illustrative of the Geology, Botany and Archæology of the environs of Cheltenham; our own pages have been made the medium for communicating ample information respecting the former subject (Geologist vol. I. p. 14 and 199.) and we should only be incurring the charge of repetition if we dwelt upon that point; we shall therefore pass the work over with our comment to its merit only. The letters purport to be the lucubrations of three individuals engaged in the investigation of the district, but their style and the poetry with which they are interspersed (and that of a very pleasing character) strongly incline us to believe them to be the works of one mind, and if so, the author is certainly a man of very considerable talent and perseverance.

MEMOIRS.

On the Alluvium of the Bedford Level, by C. B. Rose, F.G.S., *&c.*

Having on a former occasion presented to the geological world the investigation of a *marine* deposit of the "*Modern Epoch*"; the subject I have chosen for my present communication is the alluvium of the Bedford Level, a *lacustrine* deposit of still more recent date, affording manifestations of changes upon an extensive scale, the greater part of which have probably occurred within the *human* period.

I shall avail myself of the labors of Dugdale, Camden and other topographers, in the collation of facts necessary to my views, as afterwards herein developed; trusting, that if I cannot lay claim to much that is original, I shall at least render some service to the public by concentrating matter that is scattered through various repositories, and by so doing, spare the irksome occupation of research.

This extensive flat, formerly denominated the "Great Level" but now, and for a considerable period of time, better known by the appellation of "The Bedford Level" (from its having been first successfully drained by an ancestor of the present Duke of Bedford), comprises within its area portions of the six following counties, viz. Lincolnshire, Norfolk, Suffolk, Cambridgeshire, Huntingdonshire and Northamptonshire; it possesses an extent of surface amounting to 400,000 acres, intersected and irrigated by six considerable streams and affords an outlet to the waters of nine counties.

Dugdale in his "History of Imbanking and Draining," published in 1652, gives an excellant map of the "Great Level," representing it as "it lay drowned," and those who have not access to either the first or second edition of that great work, will find its scite and extent laid down with great accuracy upon Professor Phillips's Geological Map of the British Islands recently published.

This tract of country offers an extensive and highly interesting field of inquiry to the geologist, the autiquary and the agriculturist, each in his turn may revel among its treasures, but the last alone is the favored alchemyst, who reaps and secures the *golden* harvest. Let us commence with the investigations of the geologist; and if we accompany him in his perambulations along the periphery of the Level, we shall find that in Lincolnshire, its western border is formed of the Oxford clay arising from beneath the alluvial beds; on the north, the Kimmeridge clay forms a belt of high ground, and to the east a small portion is bounded by the greensand and chalk strata, which are cut off from those of Norfolk by the estuary called the wash; from Peterborough, in Huntindonshire, to St. Ives, in Cambridgeshire, it is bounded by Oxford clay, forming its southern margin; the high grounds bounding it on the east in Norfolk are composed of Kimmeridge clay, and the inferior greensand strata; and the small portion extending into Suffolk is bounded by the chalk hills of Brandon and Mildenhall. Throughout almost its entire extent the alluvial beds repose upon the Oxford clay, having interposed generally a few feet only of "drift," composed chiefly of debris of the chalk and Kimmeridge clay, the chalk appearing in the form of small nodules plentifully interspersed through the clay. In this district of the fens (Norfolk and Lincolnshire), the Kimmeridge clay passes insensibly into the Oxford or "Clunch," there being no oolite *rock* interposed. The *sections* which I have been enabled to collect are but few, in consequence of the little inducement there exists to dip into these beds, and the probability is, that when the drains were made no records were preserved of the strata exposed, if indeed, any particular notice were at that period taken of them. The earliest section that I can find recorded, is in Dugdale; it relates to the digging for a foundation at Salter's Lode, near Downham; the succession of strata is thus described, "the silt was observed to be ten feet deep; and next below that, three feet thickness of firm moor;

then, bluish gault, which the workmen judged to have been silt originally, because being dry, it not only crumbled like it, but had the roots of woods in it; then below it, moor of three feet thickness, much firmer and cleaner than the other; and lastly, whitish clay, which is supposed to have been the very natural and bottom soil at the first, before those changes happened, either from the alterations of the course of the sea, or choking up of these outfalls."

A second section was acquired from a boring made adjoining to the river Ouse, at Magdalen Bridge; the following beds were pierced.

	ft.	in.
1. Light soil and silt	5	8
2. Strong red clay, very stiff . . .	2	4
3. Blue silt and clay	1	2
4. Moor	2 to 3	0
5. Blue loam and clay . . .	6 to 8	0
6. Moor	2 to 3	0
7. Black sand and gravel	2	4
8. Yellow sand and gravel . . .	2	6

In making the Eaubrink-cut to Lynn the beds exposed were:—

Section 3.

	ft.	in.
1. Vegetable soil and brown clay with sand .	4	0
2. Blue clay, a brick earth	3	0
3. Peat containing bones and horns of ruminants .	2	6
4. Blue clay, the upper part a black shingle .	8	0
5. Peat with alder and hazel bushes, the lower portion, clay containing roots of marsh plants .	3	0

6. Dark blue clay, a marine silt, containing the following shells in great abundance;

Cardium edule, Mytilus edulis, Tellina solidula, Lutraria compressa, and Turbo ulvæ; this bed was not cut through.

A well sunk nearly in the centre of the town of Lynn afforded the following section, No. 4.

	ft.	in.
1. Vegetable soil, and a brown loam used for making brick	7	0
2. Peat	2 to 3	0
3. Blue clay	8	0
4. Peat with alder and hazel bushes	2 to 3	0
5. Marine silt upon blue clay with nodules of chalk about	30	0
6. Oxford clay containing septariæ and fossil shells pierced to the depth of	630	0

On rebuilding a part of the works at Deuver Sluice a few years since the strata cut through were—

	ft.	in.
1. A light brown sandy loam	14	0
2. Peat	2	0
3. Blue clay inclosing roots and small portions of peat	2	0
4. Peat similar to No 2.	3	0
5. Similar to No. 1, but somewhat more argillaceous	2	0
6. Dark ferruginous sand	3	0

The last stratum reposes immediately upon Oxford clay.

The alluvial beds opened at Lynn brick fields, called Sayer's Marsh, situated to the south of the town, are

SECTION 6th.

	ft.	in.
1. A brownish loam containing marine, fresh water, and land shells	2 to 3	0
2. Stiff blue clay containing similar shells	4 to 5	0
3. Moor containing alder, birch, and other woods, with bones of the horse, ruminants and water-rat	4	0

Below the moor is a shingley gravelly bed, useless to the brick-maker and therefore not worked.

SECTION 7.

At Sutton in Lincolnshire the strata observed in digging a well are said to be the following.

	ft.	in.
1. Clay	16	0
2. Moor	3 to 4	0
3. Soft moor mixed with shells and silt	20	0
4. Marley clay	1	0
5. Chalky rock	1 to 2	0
6. Clay	93	0
7. Gravel, and water with a chalybeate taste.		

This is a very unscientific description and one that I have great difficulty in explaining, indeed, the gravel beneath 93 fee of clay is inexplicable; the chalk rock with one foot of clay above, and some portion of stratum No. 3, are probably nothing else than chalk in blue clay, a form of what has been called *diluvium*, and noticed by the late Dr. William Smith, as occurring in the eastern counties. I have introduced this section merely for its alluvial strata, and in their description also, a mystery occurs; who ever heard of "soft moor" 20 feet in thickness? I can only unravel it thus; if we compare this section with the one at the Eaubrink-cut (both upon the same level, and not very distant), and venture to decide that the strata 4, 5, and 6 of the latter section represent No. 3 of the former, we shall have our two beds of moor as found at other localities in the level, with our intermediate bed of clay, and also the shells with silt, beneath the lower bed of peat as seen at Eaubrink.

In reference to the section at Sutton, Dr. De Serra, in Nicholson's Philosophical Journal, vol. 3, quarto edition, says, "The whole appearance of the rotten vegetables we observed, perfectly resembles, according to the remark of Sir Joseph Banks, the moor which in Blankeney Fen, and in other parts of the east fen in Lincolnshire, is thrown up in the making of banks; barks like those of the birch tree, being there also abundantly found. This moor extends over all the Lincolnshire fens, and has been traced as far as Peterborough, more than sixty miles to the south of Sutton. * * * * There is a subterraneous stratum of decayed trees and shrubs, exactly like those we observed at Sutton, at Axholme Isle, a tract of ten miles in length by five in breadth." Dugdale has noticed the moor in the Isle of Axholme. The order of super-position of the alluvial strata is thus given by that able geologist, Prof. Phillips, in his Essay on Geology in Lardner's Cabinet Cyclopædia; "In some of the old lakes of Holderness, the same mechanical explanation (by warping) appears applicable: an example has been furnished (Waghen in Holderness) which shows on the same spot, first, the accumulation of violently agitated water (diluvium), then a deposit of fine clay and several layers of peat, and trees of different kinds; and over all the stumps of Pine (Scotch Fir), which seem to be in their place and attitude of growth."

The same relative position of the *alluvium* and diluvium occurs in Marshland (Norfolk), for on reference to the section No. 4, afforded by sinking the well in the town of Lynn, you will find the *latter* (in stratum No. 5) lies beneath the beds of peat and silt; it is therefore a legitimate inference from the premises herein produced, that a similar disposition of the beds of peat, silt, and clay exists throughout the level.

These alluvial beds occupy a lower level than more recent deposits, which circumstance has been attributed to their subsidence in the course of their desiccation; for "it is a fact well-known near Lynn, that the land which has been regained since the Roman sea-banks were made, is on a higher level, and of greater value than that which was enclosed by the Romans; and outside of 'Marsh land' as this tract is called, the new foreshores are sometimes *still higher.*"

Associated with the peat are subterranean forests consisting of the trees indigenous to our island; they lie buried beneath the moor; the wood, upon exhumation, is generally found to be in high preservation, particularly that of the oak, which has been, from time immemorial, converted into rafters and beams for architectural purposes.

On the precise situation in which the trees are discovered, all authorities, from the earliest to the present, agree; but, on the direction in which they lie, there is great discrepancy of opinion; from my own inquiries I am decidedly of opinion that they lie in all directions. On these points I will now cite a few authorities. And first, in regard to the stratum in which they have grown, Sir William Dugdale, says, "that in the late digging of those channels and drains, as have been made for the exsiccation thereof, great numbers of such trees, of several kinds, have been found; most of oak and fir, and few of them severed from their roots; but of such as be so severed, the roots are observed to stand in the firm earth below the moor." He also says with reference to the direction in which the trunks of the fallen trees lie, "Trees were discovered lying near their roots, and the bodies for the most part north-west from the roots."

Pennant, in his preface to the third vol. of Arctic Zoology, after stating that the "great level," had been originally a wooded country, says, "Whole forests of firs and oaks have been found in digging far beneath the moor on the solid ground; oaks fifteen feet in girth, and ten yards long, mostly burnt at the bottoms, the ancient method of felling them; multitudes of others entirely rooted up, as appears by the force of the sea bursting in and overwhelming this whole tract, and covering it with silt or mud, which it carried with it from time to time."

The Rev. N. De la Pyme writes, "In the beds of the rivers, below the marsh land, and all round to the highlands of Lincolnshire and Yorkshire, are found vast multitudes of the roots and trunks of trees of all sizes, great and small, and of most of the sorts that this island either formerly did, or that at present it does produce; as firs, oaks, birch, beach, yew, thorn, willow, ash, &c.; *the root of all or most of which stand in the soil, in their natural position, as thick as ever they could grow, as the trunks of most of them lie by their proper roots.* Most of the large trees lie along about a yard from their roots (to which *they evidently belonged, both by their situation and the sameness of the wood*), with their tops commonly north-east; though, indeed, the smaller trees lie almost every way across the former, some over and others under them."—See Philos. Trans. Hutton's Abridg., vol. 22.

"The roots of the fir-trees have been observed to lie in the sand, and those of the oak-trees in clay."—Idem.

Mr. Thompson, in his History of Boston, page 278, writes, "They (the trees) lie in all directions, and appear not to have been cut down, but to have been torn up by the operation of water."

The kinds of trees most commonly found, are the oak and fir, but they are not invariably seen together, for in Downham and Stow Bardolph fens, alder, Scotch fir, and hazel are more particularly associated; whilst in the Magdalen and Marham fens, the oak and hazel are associated; the heart of the oak is slightly bituminized, which renders it nearly imperishable. This imbedded wood is frequently raised to the amount of twelve loads per acre, and Dugdale mentions as much as 2000 cart loads in a year in some districts.

The *organic exuviæ* discovered in these alluvial beds, are, first, marine testaceæ, enveloped in silt, found at the bottom of the Eaubrink cut, the genera and species are given in that section; second, the remains of mammalia almost invariably met with in the peat, and more particularly on the upper bed; third, marine, freshwater, and land shells intermingled, and found in the greatest abundance in the beds of loam and blue clay above the peat. The mammalian remains, are the antlers and bones of the Red Deer (*Cervus Elephas*) in all parts of the fens; head and other detached bones of the ox (*Bos Taurus*); horse (*Equus caballus*), hog (*Sus scrofa*), rare, a head in good preservation has been recently found in Bardolph fen; rat (*Arvicola amphibia*); I very lately met with a lower jaw of the water-rat at the brick-yard at Lynn: and the beaver (*Castor fiber*), part of the bones of the head, with the incisor teeth *in situ*, were taken up at Littleport in the Isle of Ely. The marine shells of the upper beds consist chiefly of Mactra stultorum, Lutraria compressa, and Cardium edule*; the fresh-water include most of the species of Luimea, Paludina, Helix, Planorbis, and Cyclas usually met with in the ponds and ditches of the district; the only land shell that I have at present received from these beds is Helix aspersa.

In tracing the succession of geological phenomena which have occurred on the scite of the "Great Level," and rendered manifest by the preceding observations and sections, I will commence at the period of the emergence from the ocean, of what is now the eastern portion of England, for I consider, at that epoch, this country was a part of the great continent of Europe. In the first place then, I am led to believe, from the preceding data, that about the period of the emergence, *anterior* to it, a great *debacle*, the geological deluge, rushing southerly, swept over the out-crop of the Kimmeridge clay, and carrying onward with it a considerable thickness of that stratum, deposited it again throughout a considerable distance in its southerly course; I am led to this conclusion, from having met with the "drift," of *blue clay*, containing the fossils from the Kimmeridge bed in the line of the lesser Ouse and Waveney rivers at Thetford, Lopham, Diss, Scole, Oakley, Worlingham, and Pakefield on the coast of Suffolk. The same debacle brought the chalk from Yorkshire, depositing it in nodules, and intermingling it with the surface clay of the Oxford and Kimmeridge strata, forming the "diluvium," as seen in stratum 5 of section 4 at Lynn, but still leaving a basin of considerable depth, which had been scooped out by the violence of the torrent.

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* Thompson, in his History of Boston, page 277, says, "In the East and West Fens at the depth of seven or eight feet, between the peat stratum and the sand or clay *below* are in many places considerable quantities of cockle shells."

Into this basin after its emergence the rivers that still traversed the "Level" emptied themselves, and formed an extensive lake, whose waters were confined on the north east, and south by the greensand and chalk hills of Lincolnshire, Norfolk, Suffolk and Cambridgeshire, and on the west by the oolite hills of Huntingdonshire and Lincolnshire, being relieved of its superabundant supply, in all probability, by the valley of the Ouse and Waveney. I cannot propose to determine the length of time this lake occupied its scite, but I am disposed to believe, that when our island was separated from the continent by the disruption of the strata which united them, and the consequent formation of the trough of the German Ocean, the portion of its barrier between Wainfleet in Lincolnshire and Hunstanton in Norfolk, involved in the extensive ruin, was taken down, so that the lake was destroyed, and the natural drainage of the several counties was, from that period, effected through the new-formed channel, afterwards denominated the wash, and which continues open at the present day.

From this period a new order of things commenced, the water of the river supplying the lake, having during its continuance deposited and distributed over its bottom the debris, with which it was abundantly laden, had provided a soil charged with the elements of vegetation, which upon exposure to the genial influences of the atmosphere and light, quickly furnished a luxuriant covering, in the first instance necessarily consisting of marsh plants only; ere long the shrubs and trees to which a boggy soil is congenial sprung up, and in process of time the whole space lately occupied by the lake, became a morass studded with slightly elevated spots, above the reach of stagnant water; in which the monarch of the forest and other stately timbers fixed their sturdy roots; now also did a tidal river wend its way far within the "Level," in oscillating struggles with the freshes, carrying with its flood the shelly tenants of the deep; a fact unerringly established by the stratum of marine shells, beneath the peat, discovered upon making the Eaubrink-Cut; (see stratum 6, section No. 3.)

Sir W. Dugdale speaking of the early state of the "Level," says, "That this vast level was at first a firm dry land, and not annoyed with any extraordinary inundations from the sea, or stagnation of the fresh waters, I shall now endeavour to manifest, which may, perhaps, seem strange to many; but when it is well considered that timber trees will not grow and thrive where water for the most part stands; or in moor which by lapse of time is increased in such moist places, both the one and the other may with much probability be granted (see p. 171).

I quite agree with Sir William in regard to the state of the level during the growth of those forests, whose remains are still buried at various depths; still I consider that the learned antiquary did not revert to a sufficiently early period, when propounding his views upon the subject; for whilst *he* refers to a period not necessarily very remote from the time of the Roman invasion, *I* look back for the *earliest* state of the *level,* to the epoch of its emergence from the ocean, and of its having become a freshwater lake. Before it could possibly be a "firm dry land" its barrier must have been destroyed and the basin drained; for that it was "at first" a lake, and continued so up to that period, none I think will question, who examines, with the eye either of a geologist or an engineer, its whole extent, and the high grounds that environ it.

Dr. Stukely promulgated a similar opinion to that of Dugdale, and resorted to the aid of the terrific earthquake in accounting for the destruction of these subterranean forests, but had such an agent been the means by which they were laid prostrate, abundant evidence of such action would have been left, in the disturbance of the strata upon which they grew; but such disturbance certainly does not exist.—The Rev. N. De la Pyme, who in 1701 wrote a "Description of the Subterranean Forests of Hatfield Chace in Yorkshire" came to the conclusion "that the Romans were the destroyers of all the great woods and forests which we now find under ground in the bottom of moors and bogs;" and with regard to districts were the Roman sway was impotent or unknown, as Wales, the Isle of Man and Ireland, the destruction of many forests is charged on later conquerors. " See Phillips's Geology, vol. 2; on this opinion I must remark, that as far as relates to the destruction of the forests in the "great level," it is highly improbable that the immense number of trees which have been, and are continually met with under ground were levelled to the earth by man alone, although Tacitus in his life of Agricola says, "the Britons complained that their hands and bodies were worn out and consumed by the Romans in clearing the woods, and embanking the fens."

That the Britons labored hard, there is no doubt, under their taskmasters, in raising the embankments necessary to the protection of the fens from the irruptions of the Sea, and in felling many timbers, and clearing much ground; still when we have on record, the destruction of whole forests at one "fell swoop" by natural causes, as I will presently relate, I may venture at least to affirm, that in similar tornadoes, we have a cause more competent to the effect, than that of the labour of men's hands, had Britain at that period possessed a population equalling that of China. Mr. Lyell says, in his "principles of Geology," " We also learn that the overthrow of a forest by a storm, about the middle of the seventeenth century, gave rise to a peat moss near Lochbroom in Ross-shire, where in less than half a century after the fall of the trees, the inhabitants dug peat," and Dr. Walker mentions a similar change, when in the year 1756, the whole wood of Drumlanrig in Dumfriesshire was overset by the wind. But indeed vast numbers of the trees found underground in the "Level," particularly those associated with the upper bed of peat, must have sprung from the soil *during* the period, in which the Romans occupied the country, and after they had so far protected this district from inundation, that timber trees could flourish within it; for implements and weapons fabricated by that people are discovered *beneath* the peat.

The further tracing of the mutations in the "Level" I shall defer until I notice the proceedings of the Romans within it; which will necessarily claim my attention in the agricultural division of my subject; and next, I will detail what I have gleaned that is interesting to the antiquarian.

The earliest satisfactory information on the subject, that I can collect, is from Sir W. Dugdale, who, quoting the words of Herodian, in the life of Severus the Emperor, (Lib. iii.) writes, "He therefore (Severus) first took care to make causeys over the fens, that his soldiers might stand on firm ground, and, with ease passing over them, fight on the dry land." This fact has been confirmed by the discovery of a causeway extending from Deauver in Norfolk to Peterborough in Huntingdonshire, which was sixty feet broad, composed of gravel three feet in depth, and is now covered with moor from three to five feet in thickness. "This moor stratum, says Mr. Thompson, (History of Boston, page 277), is generally about a foot thick, upon and within it are found stag's horns, warlike instruments, and other remains of the ancient inhabitants, and upon its surface, several canoes of a particular form and construction have been discovered." Implements and weapons of the Aborigines, also funereal vessels, domestic utensils, warlike and other instruments, and coins of the Romans are frequently found beneath and within the moory stratum. Stone cells, mallets, and arrow-heads of the rudest form, constructed of flint; a singular flat stone, not unlike a hone, with its surface as if polished by the rubbing of the edges of stone or metallic celts, resembling fig. 21, page 131, in the Pictorial History of England," and said to be used for sharpening bone, were lately found in the fen at Marham in Norfolk. Brass celts of the usual forms are numerous; one also has been found, of the simplest and probably of the earliest kind in metal, a mere flat piece of brass, shaped into the form of a double axe and intended to be fixed in a cleft handle; I met with it at Southery in this county. Fragments of Querras, and a few in good preservation, are very commonly found, constructed of a Breccia or pudding-stone, analagous and probably identical with that of Hertfordshire.

We learn also, as already noticed, that canoes have been discovered, and it seems, in various parts of the Level. "On cutting a drain parallel with the river Witham, about two miles east of Lincoln, between that city and Horsley deeps, an ancient canoe was found in April 1816, at the depth of eight feet from the surface; it seemed hollowed out of an oak tree, thirty feet eight inches long, and measures three feet in the widest part; the thickness of the bottom is between seven and eight inches." Three other canoes of the same character, have been removed from the fens around Lincoln, one of these is deposited in the British Museum.

In a "Cambridge Chronicle," published in June 1841, the following paragraph appeared, "As some men were employed digging gault last week in Haddenham fen, and had got about five feet below the surface, their spokes came in contact with a hard substance which they imagined would prove to be an old oak tree, many of which have been frequently found in the fens, within a few feet of the surface, but to their great astonishment, on removing the soil around it they discovered it to be an ancient canoe, bottom upwards, in length twenty-six feet, and in breadth something above four feet, with rullocks for three pairs of oars; about five feet in length was broken off the canoe in getting it out. It appeared on close inspection to be hollowed out from the trunk of a single tree." Tumuli are to be seen in some parts of the level; in the Norfolk and Cambridge portions they are rarely to be found, indeed, in those districts, the country was so entirely a morass, that scites could scarcely be met with, eligible as depositories for the remains of the revered patrician, or the honoured warrior. It appears, that they are numerous in the vicinity of Boston, for Dr. Stukely, speaking of that neighbourhood says, "Here I have not been able to meet with any remains of the ancient British, except it be the the great quantity of *tumuli* or barrows in all these parts, scarce a parish without one or more of them. They are generally of a considerable bulk much too large for Romans; nor has anything Roman been discovered in cutting them through, though a few years ago two or three were dug quite away near Boston, and another at Frampton, to make brick of or mend the highways. I guess these were the high places of worship amongst our Cambrian predecessors, purposely cast up, because there are no natural hills in these parts; and we know antiquity affected places of elevation for religious rites. No doubt some are places of sepulture, especially such as are very frequent upon the edges of the high country all around, looking down upon the Fens." Fearing that this communication will extend to an inconvenient length, I beg leave to refer the readers to the volumes of the Gentleman's Magazine for notices of coins and other relics of the olden time discovered within the field of my inquiry. I have ascertained that the Archæological Transactions do not contain any matters within the scope of my present research. The following I extract from Dugdale, "there have been divers urns digged up of late years, in the cutting of some drains through the adjacent fens: one on the north side of Wisbeach, another about Peakirk. So likewise in a place called Ford Ea (near Soham within the Isle of Ely), wherein were found burnt bone, ashes and coals; all which are undoubted testimonies that some of their colonies (Roman) had residence in these parts."—p. 174.

Of the more modern indications of the progressing civilization, and industry of man, I find mentioned by Dugdale, that in the moors at Phurne (Lincolnshire), near five feet in depth, was found a ladder of fir, of a large substance, with about forty staves, which were thirty-three inches asunder (?), but so rotten that it could not be gotten up whole, and in Haxey Carr, at the like depth, a hedge with stakes and bindings."—p. 141. Also at Whittlesea, on digging through the moor " at eight feet deep, they came to a perfect soil, and swaths of grass lying thereon as they were first mowed. And, moreover, at the setting down of Skybeck sluice, near Boston, there was found at sixteen feet deep, covered with silt, a smith's forge, and all the tools thereunto belonging, with horse-shoes, and other things made of iron, as some that saw it have affirmed to me.—pp. 177--8. Again, in the year 1635, upon the deepening of the Wisbeche river, the workmen, at eight feet below the then bottom thereof, came to another bottom, which was stony, and in it at several distances found several boats that had laid there overwhelmed with the silt for many ages." *(Dugdale.)*

Bloomfield, the Norfolk Historian, describing Higgenhall, St. Mary Magdalen says, " I have seen a memorandum by Gybbon Goddard, Esq. Sergt. at Law and Recorder at Lynn, who died in 1671, wherein he observes that in his time in digging to let down a new sluice a little beneath Magdalen Fall, which is about half a mile from Magdalen Bridge on Marshland side, there was found about 16 feet within the soil, a grave-stone of about eight feet long, and a cartwheel near to it; the grave-stone is now in Magdalen Churchyard." To return to Dugdale's indefatigable and veracious labours, he writes "near the river Welland which runs through Spalding, anno 1696, at the depth of about ten feet, there were found jetties (as they call them) to keep up the old river's bank, and the head of a tunnel that emptied the land-water into the old river; and at about twenty or thirty yards distant from the present river there were dug up (about the like depth) several old boats, on the other, viz. the north-west side of the river, and more upwards in the town, were dug up (at about the before mentioned depth,) the remains of old tan-vats or pits, a great quantity of Ox-horns and shoe soles of a very strange unusual form, with sharp-pointed toes turning up," I cannot refrain from transcribing a curious note referring to the date of the above-mentioned shoes with turned up toes, which I met with in a work published at Lynn, 1793, entitled "an Historical account of the Great Level &c. by the late W. Elstobb, Engineer," such as both Stowe, and Baker, mention to have been worn, in the time of Richard II. in 1382, "when," says the former good old author, "began the detestable use of peaked shoes, and boots tied to their knees with chains of silver gilt, or at least with silken laces:—which enormous custom continued to the fifth of Edward IV. in 1461, that is, very near fourscore years, when a proclamation was made throughout England that the beaks or peaks of shoes should not exceed two inches, upon pain of cursing by the clergy, and forfeiting twenty shillings to be paid, one noble to the King, another to the Cordwainers of London, and the third to the Chambers of London—it might have been one of these gigantic shoes, that was now found."—p. 34.

The most important of the above discoveries, as rendering manifest, the period at which the upper bed was formed, is the situation of the causeway from Deuver to Peterborough; its being found *beneath the upper moor* established the fact that the moor was not formed till after the Romans had deserted the district, which probably occurred about the time of their finally renouncing the sovereignty of England, in 427. It is no less worthy of remark, the depth beneath the present surface, at which the implements and other articles have been found, near Wisbeach, Spalding, Boston, &c., as (taking into consideration also the epoch of the draining of the Level by the Bedford family) indicating the period during which from eight to sixteen feet of mud or silt were deposited by a process analogous to what is now called *warping*.

In various parts of the "Great Level," remains of religious buildings or their sites, highly interesting to the autiquary, are to be met with, for instance at Ely, Crowland, Thorney, Bamsey, but as they are rather subjects for the historian than for the compiler of a communication like the present, I shall not occupy time by entering into any detail respecting them.

It is time now to enter upon the agricultural portion of my subject, and as the progression of agriculture will necessarily and in a great measure be shown whilst describing the changes in the physical features of the district, during its improvements by the industry of man, I will endeavour to blend this division of my subject with the agricultural; and indeed the present surface was not deposited till after agriculture had made some progress.

Of the agricultural knowledge and practice of the ancient Britons in possession of this district (the Iceni, Coritani, and Celti) nothing is on record, indeed it is probable that their food was not of the productions from tillage of the ground; for all early historians agree in stating that the aborigines subsisted chiefly on the fruits of the chace. Cæsar says, "many of the inland people sow no corn, but live upon milk and flesh; they are clothed with skins." Thomyson, in his History of Boston writes, "the higher parts of this fenny country, from the richness of the soil, were well adapted for agricultural purposes, but we have authority for supposing that agriculture was little known in this island till about 150 years before the Christian era."

The state of the Great Level as portrayed in page 76, existed on the arrival of the Romans; at that period nature alone held dominion there, man was but a denizen in the waste, the ox, the stag, and the boar ranged at large; the sagacious and provident beaver constructed his garner in its precincts.

With the arrival of the Romans in the Level, commenced the labors of man, for agricultural pursuits were unknown in Britain at that period except on the southern portion of the island. To follow the aborigines into their fastnesses in the fens, and reduce them to subjection, the invaders immediately began to clear the land, embank, and construct causeways; "The emperor

Severus is said to have been the first who intersected the fens with causeways." I have recorded one from Deuver; there appears to have been no attempt at draining the fens extensively by the Romans; their chief operations having been confined to the shutting out of the sea by raising banks. These works were necesarily preparatory to tillage, and from this period may we date the commencement of *agricultural* labors in the fens. At first their chief operations were cutting the rank grass, sedge, reeds, and turf. Camden says, "all this country in the winter time, and sometimes for the greater part of the year, is laid under water, by the rivers Ouse, Grant, Neu, Welland, Glene, and Witham, for want of sufficient passages. But when they once keep to their proper channels it so strongly abounds with a rich grass, and rank hay (by them called Lid), that when they had mown enough for their own use, in November they burn up the rest, to make it come again the thicker."

Although in the south of England corn was grown by the natives, and was, it appears, an article of exportation at the time of the Roman invasion; it is not probable, that in the state they found the fens, any portion of them was sufficiently cultivated to produce the *cerealeæ*.

As the embanking progressed during the rule of the Romans, so, no doubt, did cultivation extend, and productions increase; civilization also kept pace with the amelioration of circumstances, and therefore when they withdrew from this country, a return to the former rude state of the inhabitants, and wildness, and desolation of the country, by an entire relaxation of labour, and abandonment of agricultural pursuits, would be most improbable; accordingly the Saxons on their arrival in the island, found that the natives had made considerable progress in the knowledge and application of the useful arts; indeed there is little doubt but that the building of the towns of Wisbeach, Spalding, Boston, and Lynn commenced during the period the country was occupied by the Romans; for we learn from Cæsar, Tacitus, and Strabo, that Britian was not now in the state in which the Romans had found it; its towns were no longer barricaded forests, nor its houses wood cabins covered with straw."

On the resignation of the sovereignty of the island by the Romans in the year 427, also during the divisions and dissensions of the Heptarchy, and more particularly after the incursions of the Danes, the drains and embankments were neglected; consequently the "Great Level" was again subjected to inundations from the waters of the high grounds, and in great part became once more an almost impassable morass. The rivers bursting their barriers or overflowing their banks, would subject the lands to *repeated* inundations, layer upon layer of silt would be deposited (a natural warping) and during the time of the nearly unresisted action of these causes (a period of about 1200 years) would be formed the upper bed of moor, and the ten to sixteen or eighteen feet of silty clay reposing upon it, as seen upon examination of the strata at Boston, Spalding, and in Marshland, and divers other places. During the same period also, the monarchs of the forests, and the stately trees, which for four centuries had flourished in a genial soil, were doomed to be laid prostrate; their stability having been greatly lessened by the sodden state of the ground, they could not out-live the turmoil of the elements; but here this desolation had reached its worst, for it was slow in progress, and numerous changes on the surface ever and anon modified the features of the Level.

For several centuries after the Romans had left our isle, nothing respecting the state of these fens, appears to have been recorded; agriculture undoubtedly retrograded; the tilling of the soil was limited to small districts immediately surrounding religious houses, and the labour performed by those devout communities. Dugdale, referring to this period, writes—"Whereof the most antient mention that I have met, is about King Edward the Confessor's reign (1042-66); Egelrie, who had been a monk at Peterborough (but at that time Bishop of Durham), then making a firm causey of wood and gravel over it, from Deeping to Spalding, for the advantage of passengers"—'a most costly work, but of extraordinary necessity, which now doth, and as long as it shall last, will bear his name.' At that time, part of this province was a forest as well as a fen, and possessed by Leofrike Earl of Mercia." The same author also, quoting the History of Jugulphus, writes, that Richard de Bulos "was much addicted to good husbandry, viz. tillage and breeding of cattle, and took in a great part of the common fen adjacent, and converted it into several enclosures, for meadow and pastures. The like enclosure he also made of all his land eastward to Caer-dike, and beyond Caer-dike to Clei-dike, without Cranmore, excluding the river of Welland with a mighty bank; because every year almost all his meadows, lying near unto that stream, were overflowed with the continual inundations thereof; for which this place, called Deeping, had first that name, *id est*, a deep meadow: and erecting upon that bank divers tenements and cottages, did, in a short time, make it a large town, whereunto he assigned gardens and arable fields. And by thus banking the said river, reduced those low grounds, which were before that time deep lakes and impassible fens, into most fruitful fields and pastures; and the most humid and moorish parts thereof to a garden of pleasure." And, "Abbott Egelrie (in the times of King Edward the Elder and King Edgar), who plowed up a large proportion of them for corn, which could not have been done without the help of draining, I presume; for (saith Jugulphus), in dry years he tilled the fens in four places, at the four corners of them; and for three years had an increase of a hundred fold of what seed soever he sowed. Amongst which, that fen at Tedwarther (Lincolnshire) was the most fruitful; the monastery being so much enriched by these plentiful crops, that the whole country thereabouts was supplied therewith, and a multitude of poor people resorting thither for that respect, Crouland became a large town." The services rendered to agriculture by these focuses of industry, as exemplified within the orbit of each religious establishment, must not be measured by their limited extent; for, although the collective magnitude of cultivated ground makes but a small portion of the whole level, still, the examples they presented, and the instruction they afforded, would, but for events which unhappily soon after this period took place, have extended the blessings of civilization and plenty to every portion of that wide district. Scarcely had the contentions between the Saxons and the natives subsided, and agriculture in the fens had again been steadily pursued, when the irruption of the Danes into Mercia and East Anglia, in the year 870, not only suspended all agrarian pursuits, but carrying devastation in their course, churches and monasteries were deserted, and nearly levelled with the ground, and the country around them desolated by fire and sword. It was in this incursion of the Northmen, that "the first Christian church" at Ely, Croyland, and other abbeys were pillaged and destroyed by fire, and the abbots and monks massacred. You may judge of the humidity of the fens about Ely at this period, from the following quotations. "In the year 870, the Danes (then Pagans), led by Inguar and Ubba, made incursion into the realm, and destroyed it (the religious house at Ely); for such was the depth of the waters, which, compassing this isle, extend to the sea, that they had an easy access into it by shipping."—*Dugdale*, edit. 1772, p. 181. Again, "Canute the Great (who reigned over England from 1016 to 1036), a prince of great wisdom, valour and piety, being desirous, together with Queen Emma, his wife, and the nobles of this realm, to keep the Feast of the Purification of our Lady, here at Ely, with great solemnity, as the custom then was, the abbots of Ely, in their turn, performing the service of the King's court, as they had used to do, there being no other access to it (considering the breadth and depth of the fen), but by shipping, he set sail thitherward." *Ibid*, p. 184. And also, speaking of the island of Ramsey in Huntingdonshire, the district less drowned, Dugdale says—" In length, this island doth extend almost to two miles, but in breadth not so much, being environed with alders, reeds, green canes, and bulrushes, which do beautify it exceedingly; and before it became inhabited, was full of all sorts of trees (especially wild ashes), the length and bigness whereof may be seen by the beams and rafters on the roof of the church. But now, through the tract of time, the woods for the most gone, the fertility of the turf is such, as that the land converted to tillage beareth corn plentifully."—*Ibid*, p. 364.

If, during the turbulent and contentious times of of Saxon and Danish rule, little or no advance was effected in the way of agriculture, we may anticipate that a progressive improvement, and also an increasing taste for husbandry, ornamental as well as economical, took place after the Norman conquest, when William had apportioned to his followers the domains of those he had subdued. Accordingly, we are informed by Henry of Huntingdon, about the year 1154, that, " this fennie countrie is passing rich and plenteous, yea, and beautiful to behold, watered with many rivers running down to it, garnished with a number of meers both great and small, which abound in fish and fowl; and it is firmly adorned with woods and islands." And William of Malmsbury, who wrote about 1200, says, that the fens were a very paradise, and seemed a heaven for the delight and beauty thereof, in the very marshes bearing goodly trees, which, for tallness, as also without knots, strived to reach up to the stars. It is a plain countrie and as level as the sea, which with greene grasse allureth the eye. There is not the least portion of the ground that lies waste and void there; here you shall find the earth rising somewhere for apple-tree; there you shall have a field set with vines, which either creep upon the ground, or mount on high upon poles to support them."

There was evidently, in the above description, no small degree of romance about the said William of Malmsbury; still, taking it *cum grano salis*, it evidences that great progress had been made in the cultivation of the fens; at any rate, that large portions had not been permitted to relapse into the state in which they were found by the Romans. Still it does not appear that the Normans, at an early period of their dominions, originated any important works of drainage, but rather contented themselves with repairing the banks raised by the Romans, satisfied with confining the waters within their former channels; for, in the time of Henry I., about fifty years after the death of William the Conqueror, "there was not any other access into this isle (Ely) than by ships or boats; this bishop (Harvans) therefore, being desirous to have a causey through the fen (as it should seem), but doubting whether the monks would think the works feasible at all, or, if so, with any indifferent charge, so contrived the business, that it was set upon without any fear of either, and became accomplished accordingly. * * * Whereupon setting in hand therewith he began to measure the distance from Soham to Ely, and to cut down the reeds which stood in his way, as also to make bridges over the rivers; and so went on in raising of the said causey, which he perfected in a very short time to the wonder of all men that then saw it; that causey being still called Soham causey, and, by an ancient pleading it appeareth that before the year 1181 (27th. Henry 2nd.) there was neither any habitation, nor ground that yielded profit within that part of Wiggenhale from Busterdesdale, unto the south side of the same town, except the monastary of Crabhouse, some lands belonging thereto all being then waste, and in the nature of a fen. In 1256 (40th. Henry III.) the fens between Ely and Ramsey in Huntingdonshire, had been drained, producing corn and hay; by whom drained it is not known.

Improvements progressed as the energies of man resisted the devastating power of the elements; but at times the wind and the waves were too mighty, and prevailed over his most strenuous efforts and ingenious operations to resist them; for we find recorded, that an irruption of the sea happened in 1178, and the Country of Holland (Lincolnshire) deluged and destroyed. Again, in the year 1236 on the morrow after Martinmas days and for the space of eight days more, so boisterous were the winds, that the sea being raised much higher than its usual bounds, broke in at Wisbeach and other places of this country, so that of little vessels, cattle and people very many were destroyed. And about seventeen years after, there happened such another woful accident; also a dreadful inundation of the sea into marshland took place on November 1st. 1613 (2 Jac.) of which there is a memorial in Wisbeach Church, yet irruptions of the sea did not so much mischief as the stagnation of the fresh-waters. I have already adverted to the agricultural labors of the inmates of the religious houses scattered throughout the the Level, and the services rendered by them, in keeping the courses of the water clear in furtherance of their beneficent object. It will not be doubted then that upon the dissolution of the monasteries in the reign of Henry VIII. the works for drainage fell generally into decay; in confirmation of which, Dugdale, says, "it hath been a long received opinion, as well by the borderers upon the fens, as others, that the total drowning of this Great Level, whereof we have in our times been eye witnesses, has for the most part been occasioned by the neglect in putting the laws of sewers in due execution, in these latter times, and that before the dissolution of the monasteries by King Henry VIII. the passages for the water, were kept cleansing, and the banks with better repair, chiefly through the care and cost of these religious houses.

This eventful period, as regarded the Church property, having passed by, and extensive possessions passed into other hands, the new proprietors ere long saw the necessity, not only of repairing and keeping effective the works of their predecessors, but also that a general and greatly improved drainage would protect them from a recurrence of inundations, and reclaim large districts from the boggy waste, and convert them into highly productive lands.

One of their earliest operations appears to have been the enclosure of the fens, for in Thompson's Boston, I find that "In 1549 there appears to have been some attempt made at closing the fens, for Stow says a proclamation for enclosing the commons at Somersetshire, and Lincolnshire, made a commotion."

The following century, in the reign of Charles I. the complete drainage of the Level was projected, and in the year 1630 under the directon and auspices of the Earl of Bedford, this great work was commenced; this enterprising nobleman however was destined to suffer the heavy disappointment of failing to effect the object contemplated; still, after the interval of a few years, the undertaking was again entered upon by his son, and in 1653 completed, to the satisfaction of the parties interested therein, when the Earl and his participans received 90,500 acres, the stipulated recompense for the money expended, and the anxiety experienced; indeed, the latter was in no trifling degree, as during its progress, impediments to the great work were frequently met with, particularly from the lower orders, who, unwilling to lose their occupation of fishing and taking game, their principle means of subsistence, and not less disinclined to forego the pleasures of the chase, to which they had been so long habituated without molestation, they resisted the draining and enclosing of the lands, by repeatedly injuring the banks and drains. The following instance is recorded by Dugdale; speaking of the drainage, he says, "by which works (An. 17 Carolii.) the water was so well taken off, that in summer this whole fen yielded great stores of grass and hay; and had been made winter ground in a short time, but that the country people taking advantage of the confusions throughout the whole kingdom, which ensued soon after the convention of the late long parliament (as is very well known) possessed themselves thereof; so that the banks and sewers being neglected by the adventurers, it became again overflooded and so remaineth at this time." 1652.

Even Cromwell, during the Commonwealth, whose name stood first on the list of Commissioners of Sewers appointed by the Lords of the Privy Council of King James, to enquire into the feasibility of the drainage, permitted the peasantry and malcontents (courting popularity with them), to make similar depredations upon the works with impunity, and trespass upon the hunting-grounds, before preserved with considerable rigour by the unfortunate Charles. The Restoration bringing with it internal peace, secured to the occupier of the soil unimpeded labour in agricultural pursuits; the works of the drainage again proceeded uninterruptedly, and "on the 25th of March, 1653, the Level was adjudged to be fully drained." The great work completed, a new era in agricultural proceedings commenced; for although heretofore, at an early date, patches of the Level around religious houses, had been tilled and sown with corn; and at the time immediately preceding the general undertaking of the drainage, the South Level, was in a flourishing condition," hundreds of acres giving pasturage for sheep in the hardest time of winter, feed for three or four hundred milch cows for dairies, and on which the farmers fed their working horses, and bred stores of young cattle which were kept on the common in winter, time out of mind." (See Badeslade's History, p. 81). Still it was not till this period, that the labours of agriculture became general; now rape and rye, afterwards oats and wheat, were sown and harvested, and abundant crops gave ample earnest of the richness of the soil; Dugdale states that, "Since the drainage of Haxey Car (1631) a great part thereof has been sowed with rape and other corn for three years together, and borne plentiful crops." Again, "That of the said drained grounds (in Lincolnshire), they have usually had three quarters and a half of wheat upon one acre; three quarters of rye on one acre; and eight quarters of oats upon one acre; and for six years together, seven quarters of oats on one acre." Improvements in drainage and tillage followed quickly upon each other, although the cultivators of the soil were frequently exposed to the disheartening and destructive effects of partial inundations, and at times to an extent, productive of ruinous consequences; for man, not naturally a passive spectator during the most trying circumstances, his energies roused by the exigencies, renews his toils; again the waters flow in and are confined to their natural channels, and a highly fertile soil is liberated, and in perpetuity protected from the dominion of the elements, rivalling in the production of the *cerealeæ*, the richest clay soils of the uplands. Thompson, in his History of Boston, speaking of the fertility of the soil, writes, "as arable, these meadows are of the very best quality, producing wheat, oats, and beans, in great abundance; and if we except thistles, are not much infested with weeds. No land in the kingdom produces greater crops of wheat or beans; and the crops of oats are nearly in proportion. A practice not unfrequent in these marshes, is, to take crops of corn year after year, to a degree which would seem incredible to the occupiers of poorer soils. Some idea of the strength of the land may be formed by the fact, that ten crops of corn have been taken in succession from it, without any intervening fallow or crop of green winter food." We may judge of the luxuriance of the crops, from the statement of the same author, that "In the years 1811 and 1812, one third of the whole quantity of oats which arrived in the Port of London were shipped from Boston."

To give the proceedings in agriculture on the Level *seriatim*, would be to write an essay on that science; I shall therefore in illustration of the progress of improvement nearly up to the present time, merely bring before you an extract from an Eulogy on the late Duke of Bedford, F.G.S. and pronounced by Dr. Buckland, in his Anniversary Address to the Geological Society, delivered in 1841. "Many and honourable are the wreaths that intertwine to form the civic crown of John late Duke of Bedford, the just reward of his various and unceasing labours to advance the useful and ornamental arts of peace and ameliorate the condition of his country; but from none of these labours will he derive more lasting fame, and a higher title to the gratitude of posterity, than from the great improvements in the agriculture of England which have followed from the example he has set; and from the completion he effected, of that great and difficult operation, the perfect drainage of the fens connected with the Bedford Levels. In this drainage he has finished a work fraught not only with private emolument to himself and the other proprietors of the vast tracts of valuable land recovered from a state of unwholesome and unprofitable swamps, but pregnant also with national advantage, by augmenting the productive powers of the soil of England; and glorious as forming the consummation of a work of ages, which began with the Roman conquerors of Britain, and continued at various intervals by the successive possessors of the country, has received its full accomplishment under the auspices of the noble family of Russell." The following note is also appended to the èuloge, and as it contributes information, which exhibits the amount of advantage already reaped within the Level by its drainage and cultivation, I insert here without further preface. "We may form some estimate of the public as well as private benefits resulting from operations of this kind, from a case of a tract of fen in the Isle of Ely, called Padsols, of which in the year 1800, 800 acres were sold for 800 shillings; in 1816, part of this fen was let for 2s. 6d. an acre; in 1832 when the drainage was nearly completed, it was let for 10s. and is now let for 40s. an acre. The rent of this whole district has increased sevenfold since 1830.

I have now confirmed my early prediction, that of the three labourers in the Great Level, the geologist, the antiquary and the agriculturist, the last only, Midas-like, would turn his toils to gold. But the advantages arising from the drainage and tillage of the soil are not confined to the mere production of the necessaries of life; for the lowing herds and waving crops have not more propitiated the bounteous Ceres, than have the limpid streams and verdant fields, the no less beneficent Hygeia; the bountiful increase of the food of man having been accompanied with the blessings of health and longevity. The increased salubrity of the fenny districts is satisfactorily established by the following extract from the Report of Mr. Marshall, jun., the clerk to the Union of the Isle of Ely, inserted in the Poor Law Commissioner's General Report on the sanitory condition of the labouring population of Great Britain;" drainage, embankments, and enclosures have given stability to the soil (which in its nature is as rich as the Delta of Egypt), as well as salubrity to the air. These very considerable improvements, though carried on at a great expense, have at last turned to a double account both in reclaiming much ground and improving the rest, and contributing to the healthiness of the inhabitants."

On reference to a very perfect account of the baptisms, marriages and burials in Wisbeach from 1558 to 1826, I find that in the decimal periods, of which 1801, 1811, and 1821, were the middle years, the baptisms and burials were as under:—

	Baptisms.	Burials.	Population in 1801.
1796 to 1805	1627	1535	4710
1806 to 1815	1664	1313	5209
1816 to 1825	2165	1393	6515

In the first of the three periods the mortality was 1 in 31; in the second 1 in 40; in the third 1 in 47; the latter being less than the exact mean mortality of the kingdom for the last two years. (See Registrar General's Second Report, p. 4, fol. edit.) These figures clearly show that the mortality has wonderfully diminished in the last half century, and who can doubt but that the increased salubrity of the fens, produced by drainage is a chief cause of the improvement."

In conclusion I have but to state, that from the inquiries and researches detailed in the preceding pages, respecting the mutations which have taken place in the "Great Level," I feel warranted in drawing the following inferences.

First. That about the period of the emergence of the Eastern portion of England from the ocean a debacle passed over it, which deposited the drift upon the Oxford and Kimmeridge clays, the substrata of what is now the Bedford Level.

Second. That, after the elevation of the Level above the ocean, a lake was formed, the superfluous waters of which passed off by the valley of the lesser Ouse.

Third. That upon the disruption of the solid strata on the eastern margin of the lake, at the time of the formation of the trough of the German ocean, the lake was drained through the embouchure now called the Wash.

Fourth. That after this catastrophe, the Level became a morass, with the more elevated spots clothed with forests; and the *moor* was formed, which now constitutes the lower bed of moor in the *sections,* it having been covered by silt deposited by the *freshes* from the high grounds.

Fifth. That this was the state of the Level upon the arrival of the Romans, who embanked, cleared, and cultivated portions of it.

Sixth. That upon the retiring of the Romans from this island, the Level again became a morass, and a second time drowned by the *freshes;* forming and depositing, during the interval between the retirement of the Romans and the commencement of its drainage by the Earl of Bedford, the upper bed of *moor* and the silt reposing on it constituting the present surface of the Bedford Level.

Seventh. That certain parts of the Level were subject to inundations from the sea, and consequent despositions of its silt, containing marine testaceæ, as exemplified in the brick-field at Lynn, and near to Boston.

List of the Fossils found in the neighbourhood of Cheltenham, with remarks, by James Buckman, *Esq., F.G.S.*

Ammonites Bucklandi, Lower Lias.

Conybeari, ditto, frequently found very much flattened and covered with irridescent nacre, in which state it is A. Johnstoni, Min. Conch. f. 449.

rotiformis, Lower Lias (rare).

Turneri, ditto.

multicostata, ditto.

Brookii ditto (rare).

Smithii
planicostatus } These two are associated in slabs in the lower lias beds.

elegans, lower lias. This shell has a distinct keel; but it is found, sparingly, mixed with many specimens having a very sharp edge; the keeled state appears to be peculiar to older individuals.

concavus, top bed of the inferior oolite.

Murchisonæ, lower lias. A rare fossil, from the middle of the lower lias beds; a specimen two feet in diameter, is deposited in the Cheltenham museum.

Stokesii, lias marlstone.

mutabilis, lower lias.

angulatus, ditto.

communis, ditto.

Walcottii, upper lias.

ellipticus, lower lias.

parvus, ditto, occurring plentifully with A. elegans.

armatus, lower lias, a very rare shell in the district.

Ammonites brevispina, lower lias, sometimes in the lias marlstone.

planicostatus, lower lias.

Greenoughii, lower lias and upper bed of inferior oolite; this shell often attains a very large size.

Birchii, lower lias.

Strangwaysii, upper lias and upper bed of inferior oolite.

Taylori, lower lias, only a portion of a single individual has yet been found here.

planorbis, lower lias; in the beds of slate which separate the beds of compact lias, at the base of the lias formations; sometimes merely the nacre is left adhering to the thin pieces of shell.

Henleyi, lower lias, this species has been named A. Beckii, in the Min. Conch. and A. Cheltiensis in Murchison's Silurian System.

annulatus, upper lias.

obtusus, lower lias.

heterophyllus, marlstone (lias); associated with a new species which I have named A. nautiliformis.

Banksii.

Humphresianus, upper bed of inferior oolite (very rare).

varicosus, upper bed of inferior oolite.

Brockii, upper bed of inferior oolite, (young specimens top of Leckhampton Hill.)

Parkinsoni, upper bed of inferior oolite (common).

perarmatus, upper bed of inferior oolite; very rare in what is termed the Gryphite grit.

Brownii, upper bed of inferior oolite, associated with the preceding species; well distinguished by the tubercles on the side.

Acteon cuspidatus, Stonesfield slate, in the collection of H. Coles, Esq. Cheltenham.

Avicula echinata, upper bed of inferior oolite; very abuudant in the gravels of the oolite.

inequivalvis, marlstone; upper bed of inferior oolite.

Anomia lineata, lower lias.

Arca cancellata, lower lias. This occurs very rarely at the bottom of the lias beds.

appendiculata, lower lias.

pulchra, lower lias.

These two occur in a bed of yellow lias immediately under the lias marlstone; they are very abundant.

Branderi, lower lias, in the lower beds a rare and beautiful little species.

Astarte elegans, oolite.

Ampullaria acuta, Stonesfield slate.

patula, ditto.

These specimens are in the collection of H. Cole, Esq., they are imperfect, having the mouth but partially visible, still their contour appears to agree with Sowerby's figure.

Belemnites pistilliformis, lower lias.

elongatus, lower lias.

pencillatus, lower lias and upper beds of the inferior oolite.

lanceolatus.

These species are generally found together, they seem to belong to a particular bed, and are seldom found to wander from it, and where they occur are few other remains.

abbreviatus, upper beds of inferior oolite.

acutus, lower lias; in the bed of the yellow lias.

Crenatula ventricosa, lower lias, yellow lias. This is called Inoceramus dubius by our local geologists, nor can I see why it has been separated from that genus.

Cucullæa oblonga, inferior oolite (upper beds) and Gryphite grit; only casts are found.

decussata, Stonesfield slate. In a bed either above or near the Stonesfield slate; I am inclined to think it a Fuller's earth specimen.

Cirrus carinatus, inferior oolite (upper beds). This shell is common to our oolite; Sowerby's figure was taken from a Leckhampton specimen.

Cardium dissimile, marlstone, upper beds of the inferior oolite.

truncatum, marlstone.

Gryphæa incurva, lower lias, common, but only in the lower lias beds; it varies in size from that of a bean to three inches in length.

obliquata, lower lias.

dilatata. Top bed of the inferior oolite. The bed in which this shell occurs is called Gryphite grit, being made up principally of these shells.

gigantea, marlstone. This shell marks the marlstone of this district.

Gervillia aviculoides, in the clay beds.

acuta, lower lias.

Hippopodium ponderosum, lower lias. These occur in two beds somewhat removed from each other; the common form is in the lower clay beds. A variety from the yellow lias beds, has the beaks larger and more remote; the upper part more concave in front; it does not run into such varieties. Gryphæa incurva is frequently attached to the specimens in the lower bed, but this shell is not found in the upper one.

Helliana expansa, marlstone.

solenoides, lower lias.

Isocardia concentrica, oolite.

Lima antiquata, yellow lias.

proboscidea, common in the upper bed of the oolite.

gibbosa, oolite; this occurs sparingly in the Trigonia grit.

rudis, oolite; occasionally with the L. proboscidea.

Melanea striata, oolite.

lineata, oolite, Stonesfield slate.

constricta, oolite.

These shells appear mostly in the same bed, viz. the Gryphite grit.

costata, Stonesfield slate. The transverse striations and longitudinal ribs agree with our shell, notwithstanding Sowerby's figure was from London clay.

Mya literata (*v. scripta*), oolite.

angulifera, marlstone, oolite.

These shells are differently named on account of the different directions of the markings, but this I think is accidental.

gibbosa, lower lias.

Mytilus pectinatus, inferior oolite of Leckhampton Hill.

amplus, in the clay above the Stonesfield slate (rare).

Modiola bipartita, oolite.

Hillana, oolite.

These two shells are found together in the Gryphite grit.

alæformis, oolite, in a bed superior to the above. It has been named Perna mytelloides in Bronn's "Lethœa geognostica."

minima, lower beds of lias. This small shell is met with in great abundance in the upper side of the slabs of compact lias, which form the base of the liassic beds.

Nautilus striatus, lower lias, varying in size from two inches across to two feet.
sinuatus, oolite.
intermedius, marlstone.

Ostrea Marshii, oolite. This shell well marks the inferior oolite.
palmetta, oolite.
acuminata, oolite and Stonesfield slate.
expansa, marlstone, and in all the beds from the Gryphite grit to the upper lias; it is very abundant in the Fuller's earth.
solitaria, oolite, rare; I have seen but one specimen, which is in the cabinet of Miss Scott.

Spirifer minimus, lower lias.
Walcottii, lower lias.
Found together; I cannot help thinking these individuals to be young and old specimens.

Pholadomya gibbosa, oolite.
lirata, oolite.
ovalis, oolite.
Murchisonæ, oolite and marlstone.
These occur together on the top of Leckhampton Hill.
producta, Stonesfield slate.

Pinna tetragona, lias and oolite, often a foot and a half in length.
affinis, marlstone.

Plicatula inflata, marlstone.
spinosa, lower lias (yellow lias beds).
pectenoides, marlstone, but not common.

Plagiostoma punctata, oolite.
cardiiformis, oolite.
rusticus, oolite.

Plagiostoma ovalis, oolite.

These shells are found occasionally in two or three of the oolitic beds.

gigantea, lower lias and oolite.

obscura, Stonesfield slate.

læviusculum, oolite.

Pecten equivalvis, marlstone. This shell marks the lias marlstone all through this district.

vimeneus, oolite.

vagans, Stonesfield slate.

duplicatus, marlstone. Found in the yellow lias, and also the lower blue clays; remarkable for having its two sides differently marked.

lens, Stonesfield slate.

Trigonia costata, oolite.

clavellata, oolite.

These two shells are constantly found in the inferior oolite, in some of the beds of which are found thousands of their remains.

Terebratula concinna, oolite.

acuta, marlstone and oolite.

globata, oolite.

perovalis, oolite.

maxilata, oolite.

biplicata, oolite.

angulata, oolite.

flabellula, oolite.

fimbria, oolite,

obsoleta, oolite.

media, oolite.

tetahedra, marlstone, very common.—

These Terebratulæ, with many unnamed species, are found scattered through the oolite beds; in some places a few of the species are very plentiful, and vary much in form.

The first volume of the Geologist contains two interesting articles, by the same author, on the oolitic and lias beds of the environs of Cheltenham; these, with the addition of the present list of fossil remains, form a most complete sketch of the geology of the district, displaying the several features in a much more distinct and intelligible form than the essays on the same subject published, not long since, as the researches of Messrs. Murchison, Conybeare and Lonsdale.—ED. GEOLOGIST.

PROCEEDINGS OF SOCIETIES.

MANCHESTER GEOLOGICAL SOCIETY.

November 24th, 1842.—G. W. Wood, Esq., M.P. F.R.S., in the chair; numerous donations announced, amongst the rest, a suite of fossils from the Himalaya mountains from Capt. Lacy.

A letter was read describing the localities from which the fossils were obtained. The specimens of organic remains consisted of fossil bones in fragments, and portions of two shells of the genus Ammonites: the former were found near the crest of the Neetee Ghaut, at an elevation of 18,000 feet above the level of the sea, and appear to have belonged to a large quadruped; one, evidently, being part of a *femur;* and the latter were discovered in a ravine, on the northern descent of the Mana or Buddreenath Pass, at a hight of about 17,000 feet. The last named shells so much resemble in appearance, colour, and character some of the Ammonites of the Lias and Lower Oolite of England, as to be difficult to distinguish the one from the other, The rock specimens comprised a *Nodule,* composed of singular radiated crystals of white quartz; and three specimens of trap rock, containing crystals of carbonate of lime.

Mr. Sopwith, explained at considerable length his model of the Forest of Dean, which occasioned an animated and interesting discusson of various mining matters and exposed the exclusive system of colliery proprietors, by which they occasioned the loss of all their observations, much to the detriment of science.

Dec. 22nd, 1842. James Heywood, Esq., F.R.S. in the chair. Mr. Binney read some notes on the Lancashire and Cheshire Drift.

This formation may be divided conveniently into local and foreign.

"The first consists of angular fragments of rocks, found lying on the coal measures, and new red sandstone, derived from the strata on which they occur, and seldom containing rocks transported from a distance, arranged without any order of stratification, and appearing as if they had been formed by the upheaving of the strata, or as if some heavy body had passed over and crushed and displaced them. The distributed fragments of coal-rocks, in the valley of the Irwell, at Clammerclough, and in the cutting at Roccress, between Stalybridge and Mottram, and the beds of sand, of a yard or two in thickness, above the upper new red sandstone, so generally found on that rock in the neighbourhood of Manchester, are good examples. The study of this deposit forms a very interesting subject for the investigation of persons acquainted with the action of icebergs on lines of coast, or the effects of glaciers; but, on the present occasion, I shall not pursue it further. The *foreign* drift may be divided into—1st, Beds of stratified and unstratified gravel and sand, containing well-rounded pebbles of the primitive, primary, and older secondary rocks, seldom exceeding the size of a man's fist. 2nd, *"Till,"* the thick deposit of marl, or brown clay, mixed with pebbles of various sizes, without any order of stratification. 3rd, Beds of stratified fine gravel and forest sand, found on elevated land. 4th, A bed, and sometimes beds, of strong brown clay, of very variable thicknesses, and often lying within the last-named deposits. 5th, Deposits of gravel and sand, both stratified and unstratified, found in the beds of valleys and low lands adjoining river and brook courses. In addition to the above named descriptions of drift, a bed of rich loam is frequently found covering the deposits in the valleys. This has evidently been brought down by the present rivers. The land in the valley of the Irwell, near Agecroft Bridge, will illustrate the nature of the soil I allude to, and may be justly termed *alluvion.* The drift does not always occur in the order above described, nor are all the members of it constantly present, as several examples hereinafter mentioned will show; but the above classification will enable me to give a clearer view of the general phenomena in the low and gently rising ground. In the vicinity of Manchester, from Pendleton, across the valley of the Irwell, to Kersal Moor, all the series may be observed in the order above mentioned. All persons acquainted with the counties of Lancaster and Chester are well aware, that the surface of the whole of the low portions of the country is covered with a thick deposit of drift, sometimes a strong clay, mixed more or less with pebbles, known by the name of marl by the farmers, brick-clay in the neighbourhood of the towns, and as "till" by the geologists, or fine forest sands or gravels, forming the light soils. Deposits of peat cover both these, but most generally the latter; and where peat is found upon the former, the bed of sand or gravel is not very thick, and a bed of strong clay nearly underlies it. These superficial deposits so envelope the country, that a view of the underlying rocks, whether new red sand-stone or coal measures, is rarely to be had, except in the great lines of drainage, or in artificial sections. The same may be said of the greater part of the profitable portions of the coal fields of St. Helen's, Wigan, Worsley, Bolton, Radcliffe, Bury, Heywood, Middleton, Oldham, Ashton, Dukinfield, Hyde, Houghton, Bradbury, and Poynton. The lower coal field occupying the higher part of the country is most free from it; but in some cases it even occurs high up on the sides of the Pennine chain, and other elevated tracts of land. In addition to the gravels and sands last mentioned, most of the beds and sides of the valleys, especially the Irwell, Roche, and Mersey, are occupied by beds of gravel and sand, sometimes, but not always, exhibiting signs of stratification. These have evidently been deposited during the time of the formation of the present valleys, through the older beds of gravel, marl, and sand, which at present, for the most part, occupy the whole of the rising ground now lying between the valleys."

Mr. Binney remarked, that the sand at Pendleton was evidently the same as that at Kersal Moor: he found the same portion of rounded coal in it. On Kersal Moor there was a little bed of clay, nearly a yard thick, mixed in the sand, near Mr. Shawcross's house, and at some points towards Poynton and Hollingwood, and in cutting the railway to Oldham, beds of clay were found in it a yard or a yard and a half thick; but this was not like the great bed of till, which in many places near Manchester, was 20 yards thick. There was no question that the till, found in sinking the new pits at Mr. Fitzgerald's colliery, came under Pendleton, and that it went under Kersal Moor. Mr. Binney decsribed the lowest portion of the drift, the older sand and gravel (No. 1) as generally consisting of gravel, composed of well-rounded fragments of granites, sienites, greenstones, white quartz, old slate rocks, and mountain limestones, all well rounded, and seldom larger than a good-sized orange; parted by beds of fine sand. It was generally found under the till in the valley of the Irwell, from Bolton to Manchrster, and was the stratum which afforded the springs generally of hard water, under-neath the till or marl. He then described the till in the following words:—

"It is the most valuable deposit of the series, and presents many interesting points of observation. It is composed of a stiff brown clay, mixed with sand, and containing a small portion of lime; for, when treated with hydrochloric acid, it effervesces. The clay, when cut down, shows its brown colour; but when allowed to cleave in the open air vertically and horizontally, as it will do when in the act of drying, the sides of the cleavages are coated with a covering of dull blue colour, probably arising from the presence of carbonate of iron. In it are mingled without any order of position, blocks of red and light-colured granites, sienites, porphyries, greenstones, basalts, and various other igneous rocks; slates of different descriptions, silurian rocks, mountain limestones, cherts, millstone grits, all the indurated rocks and coals of the carboniferous series, and magnesian limestones; *but no rocks of a more modern date* have as yet been found in it. These fragments are of various sizes, from the size of a pea to blocks of five tons in weight, lying mingled together, without any order of deposition. The external characters of the rocks in this clay near Manchester are very remarkable; some present well rounded surfaces, whilst others are angular, as if they had been just separated from their parent rocks, having scarcely undergone any attrition. The Scotch porphyries, the red granites of Shap, and the light-coloured ones of Ravenglass, and other parts of Cumberland, with various greenstones and basalts, and all the hard slate rocks, none of which are found *in situ* within a less distance than near 100 miles, are for the most part well rounded, and some of them scored with striæ. The mountain limestones are more angular; but the millstone grits, coal measure strata, and magnesian limestones, have nearly always sharp edges. All the great boulders which are seen lying about the surface in various parts of this district, are probably from this deposit of till, as I have never yet seen any excavated from other deposits."

There was a number of specimens on the table of these boulders, &c. picked from one of the clay-pits. The magnesian limestone could not have come many miles; others were peices of the common coal measure flags, quite sharp, as if they had undergone no action of water; millstone grits; a piece of limestone from the Ribble, which had undergone a good deal of attrition; and some granites, nearly all of which were round. Many of the latter in this neighbourhood show *striæ*. Fragments of coal measure rocks, some of two tons' weight, occur perfectly angular, as if from the quarry. After noticing, in general terms, the range of this drift, and the fact that, occasionally, thin beds of peat were found in portions of the till, Mr. Binney spoke of its variable thicknesses. In the valley of the brook, at Bolton near the new gas pit, it is only 11 feet thick. At Mr. Fitzgerald's new pit, at Pendleton, it reached 19 feet. In the higher parts of Manchester, it is nearly 60 feet. Between Miles Platting and Newton, it is 75 feet; at the Horse Pastures Pit, Poynton, 75 feet; at Captain Fold, Heywood, 72 feet; at the Nook, Rochdale, 13 feet 6 inches; and at the Dane Viaduct, 20 feet. The only organic remains he had found in it, were some seeds, pieces of wood and bones, in the beds of peat in the eastern parts of Lancashire and Cheshire; but, at Ormskirk, Mr. Harkness had found ten species of marine shells in it. Mr. Binney next described the gravel and sand No. 2:—

"This deposit forms the dry and light soils of Lancashire and Cheshire, and is of a very variable character, often consisting of a fine forest sand, with beds of drifted coal in it, as seen in Higher Broughton, sometimes of a fine stratified gravel of well-rounded pebbles, similar to those contained in the till, as shown at Bowdon, and more rarely of coarse unstratified gravel, as exposed at Hazel Grove. It generally caps the till, and often is found on the higher portions of the upper new red sandstone in Cheshire, as on Delamere Forest, as well as on the less elevated parts under peat bogs; but in the latter positions it seldom exceeds a yard or two in thickness, and is valuable for the purpose of manufacturing glass, the suberic acid of the peat having deprived the sand of its oxide of iron. The gently rising lands of both Lancashire and Cheshire are generally composed of this deposit; but its greatest accumulation is at the foot of the sides of the Pennine chain, and other elevated portions of the lower coal field. It occurs near Preston, with few interruptions, continues to Haigh, and from the latter place it probably extends west of Bolton to Clifton. At this point, one part of it continues along the south-west side of the Irwell, past Bury Lane to Pendleton, while another portion of it occupies the west side of the same valley under Prestwich, Kersal, and Broughton; thence through Harpurhey, Newton, Failsworth, and Droylsden, to Ashton. The tract of country comprising Stand, Pilkington, the Heatons, Alkrington, Middleton, Hopwood, Heywood, Rochdale, Royton, Chadderlon to Hollinwood, is for the most part on this deposit. From Ashton it continues through Audenshaw, Gorton, Reddish, and Stockport, to Hazel Grove on one side; while the other runs through Denton, Hyde, Hattersley, Houghton, Dan Bank, Marple to Hazel Grove, and thence into the Cheshire plains, where I leave it for my friend Mr. Ormerod, who is much better acquainted with the country, to follow. The highest parts on which I have observed it are above Royton, at Roccress, near Stalybridge, and at Hattersley. It also occurs in many elevated points in Cheshire. The dip of it is often considerable. As to its organic remains, marine shells have been found in it at Preston, by Mr. Gilbertson. I have met with the Turritella *terebra,* Cardium *edule,* and a portion of another bivalve, below Haigh Hall, in a gravel pit shown me by Mr. William Peace. The same shells have been discovered on the line of the Bolton and Preston Railway, below Blackrod Church. According to Mr. F. Looney, F.G.S. the gravel and sand at Ashton-under-Lyne affords them. I have found plenty of them in the gravel pits at Bowdon; and Sir Philip Egerton, Bart. and Mr. George Wareing Ormerod, have found them in other parts of Cheshire; the former near Tarporley and the latter at a place east of the Dane Viaduct. Some geologists assert that they have found corals in it; but these are not such as have lived in the waters that conveyed the drift, but are specimens derived from decomposed boulders of mountain limestone. The sands and gravels of Preswich and Middleton afford very beautiful specimens of the Syringipora *ramulosa*, Cyathophyllum *basaltiforme*, and several other species. The fossils are quite free from any matrix, and look as if they had been detached from the spots on which they lived; and never had been imbedded in limestone. They owe their present state, no doubt, to water containing carbonic acid gas, having percolated through the strata, and removed all the carbonate of lime composing the matrix of the fossil; while the fossil itself, though composed of carbonate of lime, from some cause hitherto unexplained, has remained untouched. The same effects are seen in the fissures of the mountain limestone of Derbyshire, through which waters charged with carbonic acid flow. No. 4 deposit consists of beds of brown clay generally, but not always free from pebbles. It might be classed with the last-described deposits, as it no doubt inosculates with them; but I have put it by itself for the purpose of distinguishing it from the regular till (No. 2). The greatest thickness which I have heard of is at Jericho Clough, between Failsworth and Droylsden, where Mr. Bradbury found it seven yards thick. It is seen in Higher Broughton, on the Oldham Railway, near Fox Denton, and at other places. At Captain Fold, near Heywood, Mr. Thomas Livesey informs me that it exceeded twelve yards in thickness. As yet no fossil organic remains have been found in it. No. 5 deposit consists of beds of fine and coarse gravel and sand found in the valleys and low lands now traversed by rivers and streams, and has evidently been derived from the beds 1, 2, 3, and 4, before described. It is sometimes stratified, and frequently unstratified, and cannot easily be distinguished from No. 3, except from the position in which it is now found."

Mr. Binney closed his communication with a list of the sections he had obtained, and an appeal to the members generally to furnish facts on this subject, so that all the various appearances of the drift might be collected, and thus some light be thrown on its origin. They might compare the phenomena of drift in this neighbourhood with the valuable information relative to the action of glaciers, as observed by Agassiz and others; as well as the facts afforded by voyagers, of the actions of icebergs on lines of coast, and in the end arrive at a true theory of the origin of drift. In the course of his observations Mr. Binney said that there was on Cheetham Hill, either a bed of peat, or the remains of an old pond of considerable extent. The dip of the gravel and sand No. 3, at Pendleton, was about 8 degrees to the S.S.W. He also stated, that Mr. Harkness would have a paper for the society's next meeting, on the drift of Ormskirk. The thanks of the meeting having been given to Mr. Binney for his communication, the Chairman suggested that an outline map, at all events, might be laid down, and expressed a hope that Mr. Binney would colour the large map of the county. The valley of the Irwell seemed to be a bay of some great sea. Mr. Binney thought there was little doubt but that these valleys had been formed under the ocean. He could not colour a map, without a much greater collection of data. They could take a section from Liverpool up to the Summit Tunnel on the Liverpool and Leeds Railways, and it would show the new red sandstone at Liverpool without much drift; at Rainhill there was very little till you come down from Sutton, and you begin at Newton to come to cuttings, and then the drift was seen. At Chat Moss Tavern there was more sand; but it was chiefly till. Under Chat Moss there was no chance of seeing it; and near the Eccles New Road, you get into the till, and you cross into Salford upon it. Then the low parts of Salford and Manchester were on the gravel No. 5. At Hunt's Bank you come to the stiff till; and, crossing St. George's Road, there was nothing but till, which continued to the Moston Cutting, and thence to Fox Denton, where it was succeeded by the sand, and tbe line seemed to go over that deposit nearly all the way to within two miles of Littleborough. Mr. Gooch, the engineer of the Manchester and Leeds Railway said, there had been a quantity of it at Littleborough, which they had been obliged to remove; but he had never observed it beyond that place. Also, that in sinking a shaft at Collyhurst, through the till, he found it at ten yards; then one yard of sand, and then the coal shale.

Dr Black said, that, though often adrift as to this drift, he was led to think that the deposits were nearly simultaneous; and according to the velocity and depth of the immense current of water which must have gone over the country, were these deposits found in the hollows. The sides of hills to the N. or N.W. were generally bare and all the drift was found on the other or lee sides. At the confluence of our streams and rivers was found a great abutment of sand and gravel; instances of which he specified at Pendleton, and at the junction of the Irk and Irwell, and the Irwell and Medlock. His observations at Pendleton led him to say, that the dip was not as laid down in the section exhibited by Mr. Binney; but that at Pepper Hill it was towards the valley. It seemed to have been a large bay, and the pebbles were ranged parallel, as on the Beach at Dover. The water seemed in the course of time to have retired, leaving a very large bay between Agecroft Bridge and Pepper Hill. He regarded it as result of tidal action throwing up waves upon a lagoon, and so ultimately throwing it entirely out of the country. As to organic remains, he had frequently found in the till layers of coal, and in one instance, a very nice specimen of *Unio.* This till was supposed by many to be the result of glacial action; but to him the deposits of till and gravel seemed entirely owing to the position of the country, and the nature of the current and body of water; all these deposits containing, more or less, fragments of the country over which the waters would flow.—Mr. Binney believed that the till under Chat Moss was of very great thickness, and then came a bed of sand. He did not undertake to account for the drift, but rather wished to see facts collected, for it was useless to theorize without facts; as had been too much the practice as to drift. He expressed an intention to give a separate paper on the subject as to the neighbourhood of Manchester, and a hope that Mr. Ogden would favour him with some facts as to the drift at Hollingwood. Mr. Ogden promised to do so. Mr. Binney said that, as to the gravels, they were sometimes stratified, sometimes not, but rocks of No. 2 had quite a different appearance. He was looking the other day at the large boulder on Stony Knolls, Broughton, weighing at least five tons, and beside it he saw little pebbles of granite, greenstone, &c. in the clay, not more than the size of peas. Now what kind of current would it require to carry along the mass of five tons, and yet to deposit beside it, these very small fragments of granite? Suppose, however, a large iceberg, which when it came so far south, melted, and dropped at the same time the large mass of granite and the little pebbles, there would be no need of an enormous current to account for it.—Mr. Gooch said, that in the Olive Mount excavation, on the Liverpool and Manchester Railway, the boulders were very numerous; not fewer than 20 exceeding from two to three feet in diameter, and perfectly sound. There had evidently been great friction upon them, by some means or other. Mr. Binney said that M. Agassiz mentioned instances of boulders polished as if by a lapidary; and many of the pebbles he (Mr. Binney) had found in the clay, showed the *striæ* and other marks of the polishing process. He showed some very perfect fossil shells from Bowdon, which he said could not have rolled far. Mr. G. Greaves said that at Tafford Moss there was no till immediately under the peat, but a very fine bed of sand, almost white; but in the neighbourhood he had seen a thick bed of it, where they had sunk for draining. Dr. Black said it was the same at White Moss, which was all underlaid by the clay. Mr. Binney said, that, near the New Independant College, there was a little bed of peat and sand immediately under it; but the foundations of that edifice were all on the solid till. In the valleys of the Trent and the Ancholme, in Lincolnshire, there was no till whatever upon the peat; but it was found at Hornsea, Norfolk, and along the coast. The ten different species of marine shells found by Mr. Harkness, at Ormskirk, would go very far to make the till a tertiary and not a post-tertiary formation. They occured in the clay, and one of them was a warm sea, like one in the Mediterranean. Some of them had not been found near Manchester, neither in the till or in No. 3. Mr. Gooch said, he had never seen any in the till.

January 26th, 1843.—J. Heywood, Esq., President, in the chair.

A paper was read, entitled, "*Remarks on some parts of Prof. Agassiz's Glacial Theory,*" by Mr. Robert Harkness.

"M. Agassiz has, in an essay published is the Edinburgh New Philosophical Journal, for October 1842, detailed in a very lucid manner his observations on the applicability of the glacial theory, and some very important phenomena, which he has observed on the Mer de Glace, during his abode last year on the glacier of the Aar. In the paper referred to, he treats of the erratic phenomenon as it occurs in Great Britain, under three categories:—1st, The phenomena proper to the interior of valleys; 2nd, the dispersion of erratic blocks in plains, at great distances from their origin; and 3rd, parallel terraces. It is to the 2nd, or the dispersion of erratic blocks in plains, at great distances from their origin, to which I shall at present refer, and endeavour to show that one of the deductions in that part of the essay is not legitimate. In this portion of the essay Agassiz commences by mentioning the generality of the occurrence of the erratic deposit; after which he details, in a general manner, the nature of the deposit; he then considers the incapability of currents to convey masses of rock from their present source. The action of glaciers is then discussed, and a description of what takes place during their motion is then given.

"After this description, he commences the theoretical part of this portion of the essay, by supposing that, during a certain geological epoch, the ice extended as far from the North Pole as it does at the present time from the South, or that its extreme limit was about 50 degrees of north latitude. To this epoch he refers the scratching and polishing which is so common in mountainous countries, and also the transportation and polishing of erratic boulders. This epoch was succeeded by another, during which the ice retreated to a more northerly limit, leaving only the mountains and their valleys covered with glaciers. 'There would thus,' to use the words of the author, 'be two very distinct periods to be particularized in the epoch of the existence of ice in the north of Europe—that during which the general covering enveloped the region, and that when glaciers existed only in high valleys.' After discussing the action and depth of the ice during these two epochs, he proceeds to consider the relation which these masses of ice bear, as to time, and to the present race of organized beings of our epoch being created successively after the commencement of the retreat of the ice.' This opinion necessarily supposes the destruction and re-creation of organisms of the same species; for we find that the following shells are common to the three eras of the tertiary formation, and are still in existence at the present time, viz.—*Dentalium entalis, Dentalium strangulatum, Fissurella Græca, Bulla lignaria, Rissoa cochlearella, Murex fistulosus, Murex tubifer, Polymorphus gibba, Tubiculina oblongata, Lucina gibbosulla, Isocardia Cor* and *Nucula Margaritacea.* This supposition of destruction and re-creation is, as far as I am aware, contradictory to any analogy which preceding formations afford.

"There is another circumstance in the essay to which I more particularly refer, when I state that one of the deductions appears to me not to be legitimate. This deduction is based on a statement of Mr. Smith, of Jordanhill, who, to use the words of Agassiz, 'was the first to point out in the post-tertiary clays, *which are superior to the till,* numerous fossils of species that no longer exist, similarly associated on the neighbouring coasts.' But though this observation of Mr. Smith's may be correct, so far as his immediate locality is concerned, it is far from being a circumstance of so general occurrence as to justify the conclusion that the post-tertiary fossils belong to an epoch posterior to the erratic boulder formation. On the contrary, in the western parts of Lancashire, marine remains of the following genera, namely, *Turritella, Buccinum, Cardium* and *Venus;* also corals of the genera *Caryophyllia* and *Cellepora**—are frequently met with at all depths in the clay deposit, and are in general *associated with the transported boulders which have been derived from the primitive rocks of Cumberland.* Nor is this a merely local circumstance; for Sir Philip Egerton has found a bed of gravel containing marine shells of recent species, *under* the ordinary sandy diluvium of Cheshire, which abounds in transported boulders. Other cases might be cited to show that the shell deposits are not posterior to the diluvial formation. Phillips, to use his own words, considers that 'generally the great masses of diluvium, and the large and far-travelled boulders, which are supposed to indicate cataclysmal movements, *lie upon such shelly beds.'*

"The circumstance of marine mollusca being contemporaneous with the transportation of erratic blocks, militates strongly against the theory which supposes the boulders to have been polished and transported by the dilation of an immense arctic glacier, which, at a certain epoch, covered the greatest portion of the British Isles; for, if such a glacier ever thrust itself into the bays which are so common in some parts of Great Britain, it is very probable that such fragile things as shells would have been reduced to an impalpable powder. To what cause, then, it may be asked, are we to refer the transportation of erratic blocks? To a circumstance which still continues to operate even at the present time, viz. the transportation of rocks and earthy matter, by icebergs, which have originally been portions of arctic glaciers. These icebergs have, during their existence as parts of the arctic glaciers, detached portions of rock from the mountains on whose side they rested, by the dilatation of their mass, effected by the congelation of infiltrated water; and, after being separated from their parent glacier, have, by the influence of currents and winds, been carried to a more temperate latitude, where they have deposited their foreign matter, in consequence of the action of solar heat; and most probably produced on the bed of the ocean a formation very much resembling the erratic block deposit.

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* These are both recent species—the one being probably the *Turbinolia Borealis* of Fleming, and the other the *Cellepora pumicosa,* both of which exist in the British seas. They occur in the clays, and not the sands and gravels, in which mountain limestone fossils have been found in some other parts of Lancashire.

"This conclusion which necessarily supposes icebergs to have been transported to localities where they are now never found, is supported both by Agassiz and Smith, who believe that, at a very recent geological epoch, the *fauna* of Great Britain partook, to a great extent, of an arctic character. Agassiz is of opinion that some of the shells which are now found in the post-tertiary deposits, no longer exist in a living state in the neighbouring seas, but are confined to habitats at least from twelve to fifteen degrees of latitude to the north. Thus, for instanee, the shells of Greenland and Iceland are found fossil in the post-tertiary deposits of England and Scotland. The mollusca, which are now living on the coast of England, have had types living during the post-tertiary epoch on the coasts of Sicily.

"From these observations of Agassiz, it is evident that the British Isles possessed, during the post-tertiary period, a climate similar to Iceland; and that, from the declivities of the British mountains, glaciers frequently spread themselves along the surface of the sea, and, becoming detached, formed icebergs, which transported worn and polished blocks, derived from the mountains on whose flanks they had reposed. These icebergs would frequently become stranded on the neighbouring coasts, and, yielding to the influence of temperature, would deposit their boulders on the bed of the ocean. By these means, most probably, have the primitive rocks of Cumberland been transported to, and scattered over, the surface of Lancashire and Cheshire; and to this cause we must assign the association of erratic boulders and marine remains in the same deposit."

GEOLOGICAL SOCIETY OF LONDON.

Nov. 16*th*.—Mr. Murchison, President, in the chair. Three papers were read,

1st. "On the Structure of the Delta of the Ganges, as exhibited by the Boring Operations in Fort William, A.D. 1836-40," by Lieut. R. Baird Smith, Bengal Engineers.

Since the year 1804, a number of boring operations have been conducted in the Gangetic Delta, with a view to supply the deficiency of good fresh water in the vicinity of Calcutta, but from mechanical obstacles, without success. The geological results of the last of these experiments, commenced in April 1836, and and which were abandoned in 1840, after being carried on to the depth of 480 feet, are detailed by Lieut. Baird Smith in this memoir. After penetrating to the depth of ten feet through the artificial surface soil, a bed of blue clay, close and adhesive in its texture was entered; as the bore descended, the clay became darker in colour, till in from 30 to 50 feet, large portions of peat with decaying fragments of trees were found. This peaty stratum had been formed from the debris of forests which formerly covered the entire surface of the Delta. Succeeding these peat charged beds, a stratum of calcareous clay, 10 feet in thickness, is found, and intermixed with it are portions of the concretionary limestone, commonly known in India as Kankur. Underlying the bed of calcareous clay in which the Kankur first occurs, there is a thin bed of green silicious clay, extending from 60 to 65 feet in depth. The clay then loses its colour and continues to a depth of 75 feet, the lower portion of it furnishing nodules of Kankur. At 75 feet a bed of variegated sandy or arenaceous clay commences, and continues to the depth of 120 feet, occasionally traversed by horizontal beds of Kankur. Beneath this is a stratum of argillaceous marl 5 feet in thickness, and succeeding it there is a bed only 3 feet in thickness of loose friable sandstone, the particles of sand being held loosely together by a clayey cement. Argillaceous marl 20 feet in thickness follows the sandstone, terminating at the depth of 150 feet, when it passes into an arenaceous clay intermixed with water-worn nodules of hydrated oxide of iron. Weathered mica slate is found attached to the clay of this bed, and throughout the entire range of strata penetrated, scales of mica have always been met with. At 175 feet a coarse friable quartzose conglomerate occurs, composed of pebbles of different sizes, though none are very large, cemented together by clay. At 177 feet this conglomerate becomes smaller grained; and at 183 feet 3 inches it is found to pass into indurated ferruginous clay, which continues, with but little variation, to a depth of 208 feet. Here another layer of sandstone, soft in its upper portion, but becoming more indurated and assuming the lamellar structure, as if it passed through, occurs; the thickness being, however, no more than 3 feet. Ferruginous sand with thin beds of calcareous and arenaceous clay prevail from 208 feet to 380. Kankur, with minute water-worn fragments of quartz, felspar, granite, and other indications of debris from primary rocks are met with in the lower parts of this sandy deposit, in which were also found three fragments of bones, of which one was considered by Mr. J. Prinsep to be the lower half of a humerus of some small quadruped like a dog, and another the fragments of the carapace of a turtle. At 380 feet there occurred a thin layer, only two feet in thickness, of blue calcareous clay, thickly studded with fragments of shells, and at 382 feet this was succeeded by a layer of dark clay, composed almost entirely of decayed wood. From the lower portion of it several fragments of coal of excellent quality were brought up. Underneath this stratum and in the gravelly bed which immediately succeeds it, there was found several other fragments of fossil bones. One was considered to be a caudal vertebra of a kind of lizard, and the rest were fragments of turtles, these were discovered at the depth of 423 feet, and were associated with large rolled pebbles of quartz, both white and amethystine, felspar, limestone, and indurated clay. The gravel composed entirely of the debris of primary rocks continued to the depth of 481 feet, where the operation ceased. Lieutenant Smith remarks the correspondence of the succession of the strata in the Gangetic Delta at a depth of from 350 to 480 feet, with that observed by Captain Cautley at the base of the Himalaya. On geological grounds he concludes that had no interruption arrested the experiment, the object in view would not have been gained.

2.—"On Pipes or Sand-galls in Chalk," by Mr. Joshua Trimmer, F.G.S. In this communication the author maintains that the pipes in the chalk of the part of Kent examined, were formed by the action of the sea on a low shore, and that they marked the boundaries of the anti-eocene sea, and were subsequently submerged and covered by the London clay. Mr. Trimmer considers the form and contents of the pipes to indicate the mechanical action of water, and having the opportuity of observing the removal of the covering from the chalk near Faversham, remarked that they were but the termination of furrows from 6 to 24 inches deep in the shallowest parts exposed, but widening and deepening as they approach the pipes till they were lost in them. His opinion was strengthened by observing certain blocks of silicious sandstone marked with similar furrows and pipes, though of smaller dimensions, which could not have been formed by the action of the acidulated water. On the sea shore near Reculver, he saw similar blocks presenting pipes in miniature, the waves charged with small pebbles and sand wearing the surface with furrows like those of the chalk, the softer parts of the stone then giving way, first hollows are formed, when the rotatory motion of the contents of the hollows, set in action by the influx and reflux of the waves, drills the pipe. Arguing from anolagy, he holds that similar causes produce the pipes in chalk.

3.—"On some remarkable Concretions in the Tertiary Beds of the Isle of Man," by Mr. H. E. Strickland, F.G.S.—The northern extremity of the Isle of Man consists of an arenaceous deposit forming a district of about 50 square miles, the most extensive example of the marine newer pleiocene in the British Isles. In places it attains a height of about 200 feet above the level of the sea. Organic remains are rather sparingly diffused in it, and Mr. Strickland enumerates 20 species, of which 5 are not existing inhabitants of the British seas. Near Ramsey the beds of this deposit occasionally exhibit a very remarkable concretionary structure, the sand has been cemented into masses, which are extremely hard, and even sonorous when struck, though the sand in which they are imbedded is perfectly loose. The cementing ingredient which the application of acid proves to be carbonate of lime, seems to have been influenced in its operations partly by the planes of stratification, and partly by the directions in which the sand has been originally drifted by currents. In the former case the concretions are in the form of flat tabular masses, parallel to the stratification, often mammilated on their surfaces, or perforated obliquely by tubular cavities. In the latter case they assume a sub-cylindrical or spear-shaped form, and occur parallel both to the stratification and to each other. A pebble is frequently attached to the larger end of the concretion, which springs from it as from a root, to the length of a foot or more, and gradually terminates in an obtuse flattened point; all these varieties are sometimes combined together into vast clusters of several tons weight, resembling masses of stalactite, the component portions being nearly parallel to each other.

Mr. Strickland supposes that currents of water (or possibly of wind, operating during ebb tide) flowing in a certain direction may have disposed the sand in ridges parallel to that direction, and the carbonate of lime may have afterwards been attracted into these ridges in preference to the intermediate portions. This view is confirmed by the fact that these concretions have frequently a pebble attached to the larger end, as though it had protected a portion of sand from the current, and caused it to accumulate in a ridge on the lee side, a circumstance which may frequently be observed when sand is drifted by the wind or water.

Dec. 14*th.*—Mr. Murchison, President, in the chair.

1. "On the Ridges, Elevated Beaches, Inland Cliffs, and Boulder Formations of the Canadian Lakes and Valley of St. Lawrence." By Mr. Lyell, F.G.S. Mr. Lyell's paper was concluded on the 4th of January.

After adverting to his former paper, "On the Recession of the Falls of Niagara," and the observations which he made jointly with Mr. Hall, in the autumn of 1841, Mr. Lyell gives an account of additional investigations made by him in June, 1842, in the course of which he found a fluviatile deposit, similar to that of Goat Island, on the right bank of the Niagara, nearly four miles lower down than the great falls. The fresh-water strata of sand and gravel here alluded to occur at the Whirlpool; they are horizontal, about forty feet thick, plentifully charged with shells of recent species, and are placed on the verge of the precipice overhanging the river; they are bounded on their inland side by a steep bank of boulder clay, which runs parallel to the course of the Niagara, marking the limit of the original channel of the river before the excavation of the great ravine. Another patch of sand, with fresh-water shells, was found on the opposite or western side of the river, where the Muddy Run flows in, about half a mile above the Whirlpool. From this position of strata, it is inferred thst the ancient bed of the river, somewhere below the Whirlpool, must have been 300 feet higher than the present bed, so as to form a barrier to that body of fresh-water, in which the various beds of fluviatile sand and gravel above-mentioned were accumulated. This barrier was removed when the cataract cut its way back to a point further south. The author also remarks that the manner in which the fresh-water beds of the Whirlpool and Goat Island come into immediate contact with the subjacent Silurian limestone, shows that the original valley of the Niagara was shaped out of limestone as well as drift; hence he concludes, that the rocks in the rapids, above the falls, had suffered great denudation while yet the falls were at or below the Whirlpool. Mr. Lyell thinks that the form of the ledge of rock at the Devil's Hole, and of the precipice which there projects down the river, proves the falls to have been once at that point. An ancient gorge, filled with stratified drift, which breaks the continuity of the limestone on the left bank of the Niagara, at the Whirlpool, was found to be connected with the Valley of St. David's, about three miles to the north-west; this ancient valley appears to have been about two miles broad at one extremity, where it reaches the great escarpment of St. David's, and between 200 and 300 yards wide at the other end, or at the Whirlpool; its steep sides did not consist of single precipices, as in the Ravine of Niagara, but of successive cliffs and ledges. After its denudation, the valley appears to have been submerged and filled up with sand, gravel and boulder clay, 300 feet thick. The author passes to the general consideration of the boulder formation on the borders of Lakes Erie and Ontario; and in the Valley of St. Lawrence, as far down as Quebec. Marine shells were observed in this drift in several localities—at Montreal, attaining a height, probably, exceeding 500 feet above the level of the sea. Similar shells were found as far south as the western and eastern shores of Lake Champlain; they are all northern species, and imply a former colder climate. Rocks, in contact with the drift, are smoothed and furrowed as beneath the drift in Northern Europe. The author next describes the ridges of sand and gravel surrounding the great lakes, and regarded by many as raised beaches. Those examined preserved a general parellellism to each other and to the neighbouring coast, and some of them have been traced for more than 100 miles continuously; they vary in height, and are often very narrow at their summit, and from 50 to 200 yards broad at their base. Cross stratification is very commonly visible in the sand; they usually rest on clay of the boulder formation, and blocks of granite, and other rocks from the north are occasionally lodged upon them; they are steeper on the side towards the lakes, and they usually have swamps and ponds on their inland side; they are higher, for the most part, and of larger dimensious, than modern beaches. Mr. Lyell compares them all to the osars in Sweden, and conceives that, like them, they are not simply beaches which have been thrown up by the waves above water, but that many of them have had their foundation in banks or bars of sand; they are supposed to have been formed and upraised in succession, and to have become beaches as they emerged, and sometimes cliffs undermined by the waves. The transverse and oblique ramifications of some ridges are referred to the meeting of different currents, and do not resemble simple beaches. The author concludes that most of the ridges were formed beneath the sea or on the margin of marine sounds. Some of the less elevated ridges, however, may be of lacustrine origin, and due to the oscillations in the level of the land since the great lakes existed; for unequal movements, analogous to those observed in Scandinavia, may have uplifted fresh-water strata above the barriers which divide Lake Michigan from the basin of the Mississippi, or Lake Erie from Ontario, or the waters of Ontario from the ocean. Considerable differences of level may have been produced in the ancient beds of those vast bodies of fresh-water, while the modern deposit and the subjacent Silurian strata may, to the eye, appear perfectly horizontal.

The author then endeavours to trace the series of changes which have taken place in the region of Lakes Erie and Ontario, referring, first, to a period of emergence, when lines of escarpment, like that of Queenstown, and valleys like that of St. David's, were excavated; secondly, to a period of submergence, when those valleys, and when the cavities of the present lake basins, were wholly or partially filled up with the marine boulder formations; and, lastly, to the re-emergence of the land—during which rise the ridges before alluded to were produced, and the boulder formation partially denuded. He also endeavours to show how, during this last upheaval, the different lakes may have been formed in succession, and that a channel of the sea must first have occupied the original valley of the Niagara, which was gradually converted into an estuary and then a river. The great falls when they first displayed themselves near Queenstown, must have been of moderate height, and receded rapidly, because the lime overlying the Niagara shale was of slight thickness at its northern termination. On the further retreat of the sea, a second fall would be established over lower beds of hard limestone, and a third fall would be caused over the ledge of hard quartzose sandstone, which rests on the soft red marl seen at the base of the hard quartzose sandstone, which rests again on the soft red marl seen at the base of the river cliff at Lewistown. These several falls would each recede further back than the other, in proportion to the greater lapse of time during which the higher rocks were exposed before the successive emergence of the lower ones. Three falls of this kind are now seen descending a continuation of the same rocks on the Genessee River, at Rochester; their union, in the case of the Niagara, into a single fall, may have been brought about in the manner suggested by Mr. Hall, by the increasing retardation of the highest cataract, in proportion as the uppermost limestone thickened in its prolongation southwards, the lower falls meanwhile continuing to recede at an undiminished pace, having the same resistance to overcome as at first. Mr. Lyell considers the time occupied by the recession of the falls from the Whirlpool to be quite conjectural, but assigns a foot, rather than a yard a year, as the more probable estimate. Thus he shows the mastodon, found on the right bank, near Goat Island, though associated with shells of recent species, to have claims to a very high antiquity, since it was buried in fluviatile sediment before the falls had receded above the Whirlpool.

2. Notice on a Suite of Specimens of Ornithoidicnites, or Footprints of Birds, on the New Red Sandstone of Connecticut, United States. By Dr. Mantell, F.G.S.

These specimens were accompanied by a letter from Dr. Deane, of Greenfield (Massachusetts), the original discoverer of these curious footmarks, of which more than thirty varieties have been found, mostly bearing a striking resemblance to the tracks of living birds; they are invariably those of a biped, and, in some instances, the progress of the animal may be followed over as many as ten successive steps. One example is fourteen inches in length.

MISCELLANEA.

Washingtonite—a New Mineral.

Mr. Shepard, M.D. of the South Carolina Medical College, thus describes a mineral recently found near Washington, U.S.

Fig. 1.

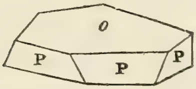
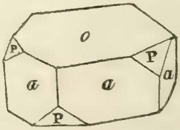


Fig. 2.



Primary form, rhomboid; P on P = 86°, as determined by the reflective goniometer, on varnished planes. Plane *o* the most shining, P, the most brilliant. The crystals, fig. 1, from

Westerley, often yield to cleavage parallel to P, with much perfection, affording faces more brilliant than any of the natural planes of the crystals. Crystals from Litchfield sometimes manifest a tendency to cleave parallel with *a*. No cleavage in the direction of *o*, unless through the intervention of quartz. Fracture rather uneven. Lustre imperfectly metallic. Color iron black; the fracture iron-gray. Streak the same, but lighter. Hardness equal to 5·75. Gravity = 4·963 from Westerley, 5·016 from Litchfield.

Before the blow-pipe, infusible; but changes to a grayish black color. Unmagnetic before and after ignition; with borax it fuses with effervescence into a clear, green glass, with a shade of yellow. With salt of phosphorus it dissolves, forming an opaque orange yellow glass, which on cooling passes to an opaque pearl white. Its powder is decomposed (without evolution of chlorine) by long boiling in hydro-chloric acid; an abundance of titanic acid separates from the solution, and the clear fluid after neutralization by ammonia and precipitation by succinate of ammonia, yields with carbonate of potassa, a slight precipitate of carbonate of manganese. It may, therefore, be regarded as some titaniate of protoxide of iron, with a small proportion of oxide of manganese.

It is readily conceded that the mineral here described is not crystallographically shewn to be distinct from the Axotomous iron ore of Moh's, or from the Chrichtonite (including Ilmenite); indeed it appears most probable that all these minerals are not only identical in their angles, but are isomorphous with specular iron. If they are specifically distinct, indications of such differences may be looked for in the modifications of their primary forms, in cleavages and in lustre; while essential differences will doubtless be found in specific gravity and hardness. The disagreements in secondary forms and cleavage are obvious from the description above given; then in lustre, color and streak cannot fail of striking any one who compares the different substances with each other. The specific gravities may be judged of from the following comparative table:

Axotomous Iron ore, of Moh's.

From Gastein, Saltzburg . .	G = 4·661	Moh's 4·723 Breithaupt 4·730
From Schwartzenberg, Saxony. .	4·178	Breithaupt.
From Arendahl, Norway	4·721	„
Erom Fredericksvairn, Norway .	4·735	„

Ilmenite.

From Ilmen	G = 4·766	4·808 G. Rose.
Ditto	4·805	Breithaupt.

Washingtonite.

From Westerley	G = 4·963	Shepard.
From Litchfield, Conn.	5·016	Shepard.

Concerning the comparative hardness of these minerals, I can only state at present that the Washingtonite is harder than the Axotomous iron ore. The beautiful crystals from Amitz and Monroe, Orange County, N.Y. belong to the species Axotomus iron ore. The Washingtonite is also found at Goshen, Mass. along with Spodumene, in thin foliæ.—*American Journal of Science.*

MEMOIRS.

Notes in illustration of the best means of preserving evidences of Botanical and other Researches in connection with Geology. By the EDITOR*.

In the February (1843) number of the Geologist (p. 46) a report will be found which at once shows the desirability of observations on the plants peculiar to particular formations, if there be any such rule—this being a question of doubt to a certain extent—and of a system being adopted, in the collection of evidence obtained in the course of the inquiry. The report in question was interesting on many accounts, not only for the very lucid idea which it gave of the vegetable productions in general of the district, but also for the short notices appended in many instances to those productions which might in a manner be said to be peculiar to one, or common to all formations—that there are plants which come under both these denominations we will not yet venture to say, although the researches of botanists have already proved distinct alpine, sub-alpine, median, and lowland species which extend to certain limits only, and beyond which they are absent.

This, moreover, is not the object of our present article—we merely wish to call the attention of field naturalists to some general system of comparison, and at a future period we trust the benefits of this system will be made apparent in the pages of this work. We need not say that the inquiry is of the greatest interest as well to the agriculturist as to the man of science, and is therefore worthy of attentive study.

General Instructions.

The following particulars of each district are most desirable, viz.:—

1. A description of the nature of the district—its extent, elevation, and natural features in general.

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* For the botanical department we are indebted to James E. Moxon, Esq.

2. The distribution of strata, and the accordance of particular rocks at the various elevations, or otherwise.
3. A tabular statement of the number of genera and species of plants in each of the natural orders, for which we have annexed a list, and the subdivision of these according to the soils of the district*. (This enumeration had better be made in columns—to the left of the page place the designations of the natural orders at length, and to the right a sufficient number of columns for the general estimate and each of the several strata.)

The Natural Orders of Plants,

According to the arrangement of Lindley (Nat. System of Botany, 2nd. Edition, 1836.)

Class I.—Exogenæ; or Dicotyledones.

Sub-Class I. Polypetalæ.

Order 1. Ranunculaceæ.
Sub-Order. Podophylleæ.
2. Papaveraceæ.
Sub-Order Fumariæ.
3. Nymphæaceæ.
Sub-Order Hydropeltideæ.
4. Nelumbiaceæ.
5. Cephalotaceæ.
6. Myristicaceæ.
7. Magnoliaceæ.
8. Winteraceæ.
9. Anonaceæ.
10. Dilleniaceæ.
Order 11. Umbelliferæ.
12. Araliaceæ.
13. Grossulaceæ.
14. Escalloniaceæ.
15. Bruniaceæ.
16. Berberaceæ.
17. Vitaceæ.
18. Pittosporaceæ.
19. Olacaceæ.
20. Francoaceæ.
21. Sarreceniaceæ.
22. Onagraceæ.
Sub-Order Circæeæ.
Sub-Order Hydrocaryes.
Sub-Order Halorageæ.
23. Combretaceæ.

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* Observers must be cautious in not regarding surface soil as the only indication of sub-soil—for although a chalky soil almost invariably indicates chalk at a very small depth from the surface, yet the loams and clays are often only common coverings of numerous and important strata.

Order 24. Alangiaceæ.
25. Rhizophoraceæ.
26. Memecylaceæ.
27. Melastomaceæ.
28. Myrtaceæ.
Sub-Order Barringtonieæ.
29. Lecythidaceæ.
30. Philadelphaceæ.
Sub-Order Maquinæ.
31. Hamamelaceæ.
32. Cornaceæ.
33. Loranthaceæ.
34. Cucurbitaceæ.
35. Loasaceæ.
36. Cactaceæ.
37. Homaliaceæ.
38. Mesembryaceæ.
39. Begoniaceæ.
40. Cruciferæ or Brassicaceæ.
41. Capparidaceæ.
42. Resedaceæ.
43. Violaceæ.
Sub-Order Sauvagesieæ.
44. Samydaceæ.
45. Moringaceæ.
46. Droseraceæ.
47. Frankeniaceæ.
48. Passifloraceæ.
49. Papayaceæ.
50. Flacourtiaceæ.
51. Pangiaceæ.
52. Malesherbiaceæ.
53. Turneraceæ.
Order 54. Bixaceæ.
55. Guttiferæ or Clusiaceæ.
Sub-Order Canelleæ.
56. Rhizobolaceæ.
57. Marcgraaviaceæ.
58. Hypericaceæ.
Sub-Order Ochranthaceæ.
59. Ternströmiaceæ.
60. Aceraceæ.
61. Sapindaceæ.
Sub-Order Millingtonieæ.
62. Æsculaceæ.
63. Polygalaceæ.
Sub-Order Krameriaceæ.
64. Vochyaceæ.
65. Elatinaceæ.
66. Linaceæ.
67. Hugoniaceæ.
68. Chlenaceæ.
69. Cistaceæ.
70. Reaumuriaceæ.
71. Sterculiaceæ.
72. Malvaceæ.
73. Elæocarpaceæ.
74. Dipteraceæ.
75. Tiliaceæ.
76. Lythraceæ.
77. Meliaceæ.
78. Cedrelaceæ.
79. Humiriaceæ.
80. Aurantiaceæ.
81. Spondiaceæ.
82. Rhamnaceæ.

Order 83. Chailletiaceæ.
84. Tremandraceæ.
85. Nitrariaceæ.
86. Burseraceæ.
87. Euphorbiaceæ.
87*. Empetraceæ.
88. Stackhousiaceæ.
89. Fouquieraceæ.
90. Celastraceæ.
Sub-Order Hippocrateæ.
Sub-Order Trigonieæ.
91. Staphyleaceæ.
92. Malpighiaceæ.
Sub-Order Erythroxyleæ.
93. Portulaceæ.
94. Silenaceæ.
95. Alsinaceæ.
96. Tamaricaceæ.
97. Illecebraceæ.
98. Ochnaceæ.
99. Simarubaceæ.
100. Rutaceæ.
101. Zygophyllaceæ.
102. Xanthoxylaceæ.
103. Geraniaceæ.
104. Balsaminaceæ.
Sub-Order Tropæoleæ.
105. Oxalidaceæ.
106. Coriariaceæ.
107. Surianaceæ.
108. Limnanthaceæ.
109. Rosaceæ.
Sub-Order Pomeæ.
Sub-Order Amygdaleæ.
Sub-Order Sanguisorbeæ.

Order 110. Leguminosæ.
111. Connaraceæ.
112. Chrysobalanaceæ.
113. Calycanthaceæ.
114. Baueraceæ.
115. Cunoniaceæ.
116. Saxifragaceæ.
117. Crassulaceæ.
118. Amyridaceæ.
119. Anacardiaceæ.
120. Cupuliferæ or Corylaceæ.

Sub-class II. INCOMPLETÆ.

121. Betulaceæ.
122. Scepaceæ.
123. Garryaceæ.
124. Hensloviaceæ.
125. Urticaceæ.
Sub-Order Ceratophylleæ.
126. Ulmaceæ.
127. Stilaginaceæ.
128. Myricaceæ.
129. Juglandaceæ.
130. Casuaraceæ.
131. Datiscaceæ.
132. Lacistemaceæ.
133. Chloranthaceæ.
134. Saururaceæ.
135. Piperaceæ.
136. Salicaceæ.
137. Platanaceæ.
138. Balsamaceæ.
139. Monimiaceæ.
140. Atherospermaceæ.

Order 141. Podostemaceæ.
142. Callitrichaceæ.
143. Santalaceæ.
144. Elæagnaceæ.
145. Thymelaceæ.
146. Hernandiaceæ.
147. Aquilariaceæ.
148. Proteaceæ.
149. Lauraceæ.
150. Illigeraceæ.
151. Cassythaceæ.
152. Penæaceæ.
153. Nepenthaceæ.
154. Aristolochiaceæ.
155. Amarantaceæ.
156. Chenopodiaceæ.
156*. Tetragoniaceæ.
157. Phytolaccaceæ.
158. Polygonaceæ.
159. Petiveriaceæ.
160. Scleranthaceæ.
161. Nyctaginaceæ.
162. Menispermaceæ.
Sub-order Lardizabaleæ.

Sub-class III. Monopetalæ.

163. Brexiaceæ.
164. Pyrolaceæ.
165. Monotropaceæ.
166. Ericaceæ.
167. Vaccinaceæ.
168. Epacridaceæ.
169. Primulaceæ.
170. Myrsinaceæ.

Order 171. Sapotaceæ.
172. Ebenaceæ.
Sub-Order Styraceæ.
173. Aquifoliaceæ.
174. Nolanaceæ.
175. Cuscutaceæ.
176. Convolvulaceæ.
177. Polemoniaceæ
177*. Diapensiaceæ.
178. Hydroleaceæ.
179. Lobeliaceæ.
180. Campanulaceæ.
Sub-Order Spherocleaceæ.
181. Belvisiaceæ.
182. Columelliaceæ.
183. Stylidiaceæ.
184. Goodeniaceæ.
185. Scævolaceæ.
186. Cinchonaceæ.
187. Lygodysodeaceæ.
188. Caprifoliaceæ.
189. Stellatæ or Galiaceæ.
190. Calyceraceæ.
191. Mutisiaceæ
192. Cichoraceæ
193. Asteraceæ
194. Cynaraceæ
} or Compositæ.
195. Dipsaceæ
196. Valerianaceæ.
197. Brunoniaceæ.
198. Plantaginaceæ.
199. Globulariaceæ.
199*. Salvadoraceæ,
200. Plumbaginaceæ.

Order 201. Hydrophyllaceæ.
202. Cordiaceæ.
203. Ehretiaceæ.
204. Boraginaceæ.
205. Labiatæ.
206. Verbenaceæ.
207. Myroporaceæ.
208. Selaginaceæ.
209. Stilbaceæ.
210. Pedaliaceæ.
211. Bignoniaceæ.
212. Cyrtandraceæ.
213. Acanthaceæ.
214. Lentibulaceæ.
215. Gesneraceæ.
216. Orobanchaceæ.
217. Scrophulariaceæ.
218. Solanaceæ.
219. Cestraceæ.
220. Gentianaceæ.
221. Spigeliaceæ.
222. Apocynaceæ.
Sub-Order Retziaceæ.
223. Asclepiadaceæ.
224. Loganiaceæ.
225. Potaliaceæ.
226. Oleaceæ.
227. Jasminaceæ.

Class II. Gymnospermæ.

228. Gnetaceæ.
229. Cycadaceæ.
230. Coniferæ or Pinaceæ.
Order 231. Taxaceæ
232. Equisetaceæ.

Class III. Endogenæ; or Monocotyledones.

233. Zingiberaceæ or Scitamineæ.
234. Marantaceæ.
235. Musaceæ.
236. Amaryllidaceæ.
237. Hæmodoraceæ.
238. Burmanniaceæ.
239. Taccaceæ.
240. Iridaceæ.
241. Bromeliaceæ.
242. Hydrocharaceæ.
243. Orchidaceæ.
244. Vanillaceæ.
245. Apostasiaceæ.
246. Palmaceæ.
247. Pontederaceæ.
248. Melanthaceæ.
249. Gilliesiaceæ.
250. Liliaceæ.
251. Commelinaceæ.
252. Butomaceæ.
253. Alismaceæ.
254. Juncacææ.
255. Philydraceæ.
256. Smilaceæ.
257. Dioscoreaceæ.
258. Roxburghiaceæ.
259. Pandanaceæ.
260. Cyclanthaceæ.

261. Araceæ or Aroideæ.
262. Acoraceæ.
263. Typhaceæ.
264. Fluviales.
265. Juncaginaceæ.
266. Pistiaceæ.
267. Graminaceæ.
268. Cyperaceæ.
269. Desvauxiaceæ.
270. Restiaceæ.

Sub-order Eriocauloneæ.

271. Xyridaceæ.

Class IV. RHIZANTHEÆ.

272. Rafflesiaceæ.
273. Cytinaceæ.
274. Balanophoraceæ.
275. Cynomoriaceæ.

Class V. ACROGENÆ; or ACOTYLEDONES.

276. Polypodiaceæ.
277. Gleicheniaceæ.
278. Osmundaceæ.
279. Danæaceæ.
280. Ophioglossaceæ.
281. Lycopodiaceæ.
282. Marsileaceæ.
283. Salviniaceæ.
284. Musci, or Bryaceæ.
286. Jungermanniaceæ.
287. Hepaticæ or Marchantiaceæ.
288. Characeæ.
289. Fungi.
290. Lichenes.
291. Algæ or Algaceæ.

4. After the enumeration of the species distributed over the various formations individually and the collective number of each natural order the following summaries should be added,

Table I.—Collective Estimate.

	Nat. Orders.		Genera.		Species.
Exogenæ, containing	——	including	——	including	——
Gymnospermæ	——		——		——
Endogenæ	——		——		——
Rhizantheæ	——		——		——
Acrogenæ	——		——		——
Total		Total		Total	

Table II.—Collective Distribution.

	No. of Species.				
	Exogens	Gymn:	Endogens	Rhiz:	Acrogens
Alpine and Upland	——	——	——	——	——
Rocks	——	——	——	——	——
Plains: dry ground	——	——	——	——	——
moist ground	——	——	——	——	——
water plants	——	——	——	——	——
woods	——	——	——	——	——
Totals					

Table III.—Distribution on particular soils.

This table is dependent upon circumstances, and as such we can only give an example; the rocks and soils of which the district is composed are to be enumerated to the left of the page, and the estimate carried out as in the case before us.

	No. of Species.				
	Exogens	Gymn:	Endogens	Rhiz:	Acrogens
I. Total of estimate	——	——	——	——	——
Chalk	——	——	——	——	——
Chalk Marl	——	——	——	——	——
Greensand, lower	——	——	——	——	——
Greensand, upper	——	——	——	——	——
II. Total of estimate as above . . .	——	——	——	——	——

5. A tabular statement of the distribution and number of the distribution of the fossil flora, if any.
6. A tabular statement of the distribution and total number of recent and fossil shells, arranged according to families, of which we have annexed a list (the enumeration to be made as in the tabular estimate of the flora of the district—the first column to contain the total number of recent species of the family, the next the total

number of fossil species, and the succeeding columns, varying with the number of different formations in the district, to contain the estimate of distribution.)

CIRRHIPEDA.

CONCHIFERA.

I. *C. Dimyaria.*

1. Tubicolidæ.
2. Pholadidæ.
3. Solenidæ.
4. Myadæ.
5. Mactridæ.
6. Corbulidæ.
7. Lithophagidæ.
8. Nymphidæ.
9. Conchidæ.
10. Cardiidæ.
11. Arcidæ.
12. Naiideæ.
13. Chamidæ.

II. *C. Monomyaria.*

14. Tridacnidæ.
15. Mytilidæ.
16. Malleidæ.
17. Pectinidæ.
18. Ostreidæ.
19. Rudistidæ.
20. Brachiopodidæ.

MOLLUSCA.

I. *Pteropoda.*

II. *Gasteropoda.*

21. Tritonidæ.
22. Phyllididæ.
23. Semiphyllididæ.
24. Calyptræidæ.
25. Bullidæ.
26. Laplyisidæ.
27. Limacidæ.

III. *Trachelipoda.*

28. Colimacidæ.
29. Limnæidæ.
30. Melanidæ.
31. Peristomidæ.
32. Neritidæ.
33. Janthinidæ.
34. Macrostomidæ.
35. Plicacidæ.
36. Scalaridæ.
37. Turbinidæ.
38. Canaliferidæ.
39. Pteridæ.
40. Purpuridæ.
41. Columellidæ.
42. Convolutidæ.

IV. *Cephalopoda.*

43. Orthoceratidæ.
44. Lituolitidæ.
45. Cristacidæ.
46. Spherulidæ.
47. Radiolidæ.
48. Nautilidæ.
49. Ammonitidæ.

V. *Heteropoda.*

7. A list of fossils not vegetable or testaceous.

On the Nature and Origin of the Saline Waters of Cheltenham.

By James Buckman, F.G.S.

A subject of great interest and one which is intimately connected with the *Geology* of this neighbourhood, is that of the *Medicinal springs* which so much abound in this district; these springs depend for their therapeutic effects upon the presence of certain chemical compounds which are held in solution with the water, the most prevailing of which will be seen from the following table of the contents of 16 oz. of water taken from the Pittville Spa at Cheltenham, as deduced from my own analysis.*

	grs.
Chloride of Sodium . . .	43
Sulphate of Soda	20
Carbonate of Magnesia . . .	5
Carbonate of Soda	5
Carbonate of Lime	2
Bromide of Sodium . . .	0·3
Iodine; a trace	
	75·03

Now it will be seen from the foregoing table that Chloride of Sodium (Common Salt) is far more in quantity than any one of the other ingredients, and this fact will be useful to us in re-

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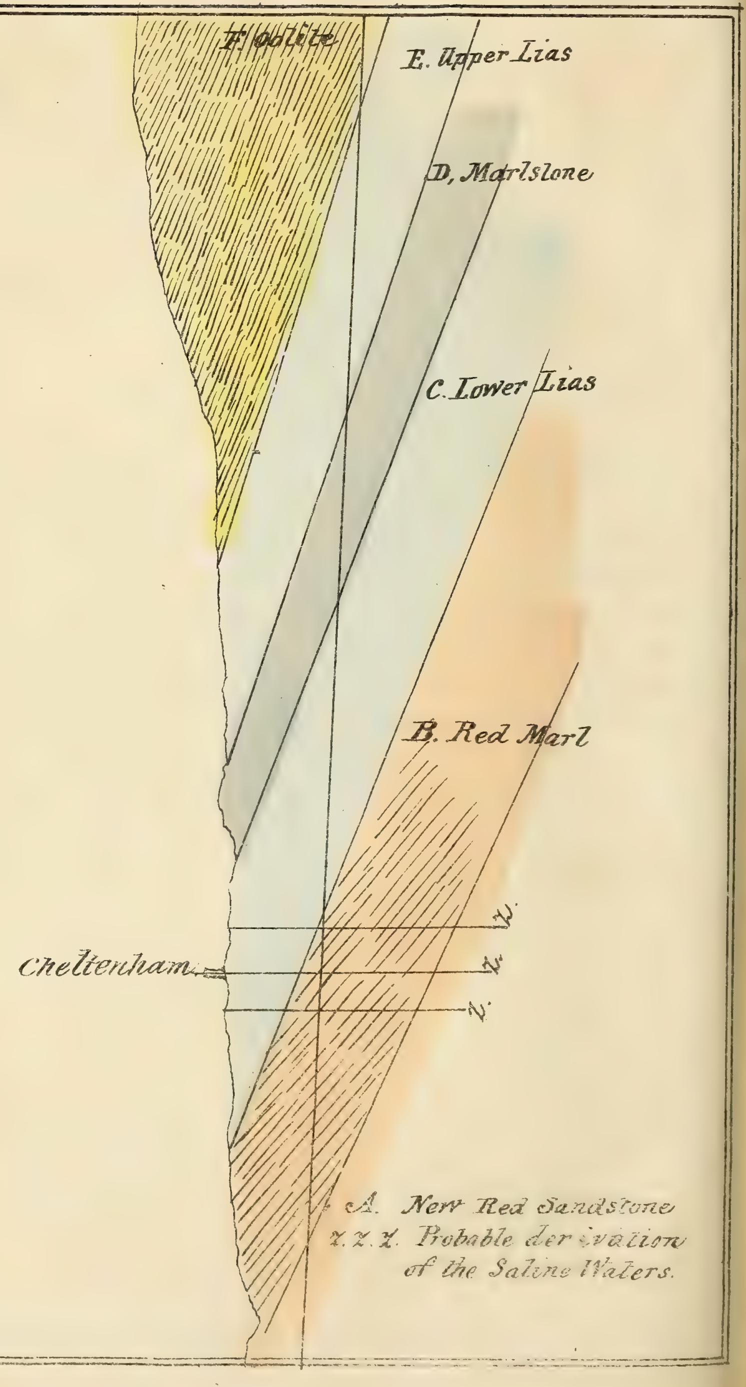
*See Guide to Pittville p. 24.

NATURAL HISTORY

Plate IV.



Section of Strata at Cheltenham, shewing the origin of the Saline Springs.

verting to the probable geologic derivation of the waters, or at least of their chemical principles.

Mr. Murchison in his Silurian System and also in a little work on the Geology of Cheltenham, has come to the conclusion that the salt springs, that is, the springs of chloride of sodium and water, are derived from the New Red Sandstone formation, and that they flow from this formation under the lias, and, from the greater elevations of most of the red-sand above the Lias on account of the dip of these beds, it finds its level by rising through the lias in any fissures or natural openings that may present themselves. This will be better understood by a reference to Pl. IV.

This salt water then, as derived from the saliferous deposit consisting of a solution of chloride of sodium, with a little chloride of magnesia in water, in its contact with the Lias becomes impregnated with the sulphates of soda and magnesia, and the carbonates of soda, lime, &c. and in proof of this position it will be sufficient to state that the deeper the lias beds which have to be pierced through in order to arrive at the saline, the greater will be the quantity of proximate principles, independent of the common salt, and the *nearer the saline* water is found on the *borders of the New Red Sandstone formation, the greater the quantity of common salt and the smaller the proportions of other ingredients.* The foregoing opinion too, as to the origin and proportion of our *medicated waters* is further strengthened from chemical experiments which developed the presence of the materials before mentioned in the lias beds, although common salt bears an inappreciable quantity compared with that which is in the water, but the muriates, carbonates, and sulphates with iron, bromine, iodine &c, may all be detected in the lias clays, and it is a fact which my own experiments have verified that these layers of shale which present us with remains of *marine plants* yield, on analysis, soda, together with small quantities of iodine; these facts then it is presumed will suffice to show that the theory which supposes the saline waters of this district to be derived from the saliferous deposits, notwithstanding the thickness of the intervening beds, is not to say the least altogether of a hypothetical character.

In a notice of the descriptive character of the present it will be necessary to state the different kinds of saline waters with which our health-restoring springs are so bountifully supplied; they may be divided into 1st, the Purgative, 2nd. the Tonic and 3rd, the Alterative; the purgative consist principally of pugative salts, as chlorides and sulphates of the kaligenous metals, in various proportions, the Tonic waters have these salts in smaller quantities, but in addition they contain some salt of iron, mostly the sulphate, which gives them their tonic effects.

The alterative consist of two kinds, the sulphur springs, which derive their sulphur from the decomposition of iron pyrites which often occur in beds in the lias, these waters are particularly recommended in cutaneous diseases, whilst the 2nd. kind of alterative, the ioduretted and bromine waters, act slowly upon the absorbents. Of course these different kinds of waters are not always exactly alike and this will account for the different result of each new analysis of them.—

PROCEEDINGS OF SOCIETIES.

GEOLOGICAL SOCIETY OF LONDON.

Jan. 4th, 1843 (continued from p. 134), a paper was read "*On newly discovered Ichthyolites in the new red-sandstone of New Jersey,*" from W. C. Redfield, Esq.

Mr. Redfield has found two distinct fish-beds in the new red sandstone of New Jersey both containing ichthyolites of the genus *Palæoniscus.* In the sandstone between the fish-beds he discovered an Ornithoidicnite, and observed numerous slabs exhibiting impressions of rain-drops and ripple-marks. The rain marks appear as if the rain had been driven by a strong wind, and the direction of the impressions indicated that the wind blew from the west, a quarter from which violent squalls or thundergusts are still prevalent in these latitudes.

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* Note—From the change of date in the publication of the Geologist, we are enabled to give the reports of these and other meetings, with greater exactitude, having the guide of the published proceedings of the Societies. *Ed. Geologist.*

January 18*th*, 1843. R. J. MURCHISON, Esq., President in the Chair; a paper was read *On the Silurian Rocks of the South of Westmoreland and North of Lancashire.* By Daniel Sharp, Esq. F.G.S. vide (Geologist vol. 1. p, 122).

This communication is in continuation of a paper read by the author on the 2nd of February, 1842, a second visit to the district having enabled him to correct some errors committed on his first examination, and to extend his observation into Lancashire.

On both occasions Mr. Sharpe took for his base-line the bed of Coniston limestone described by Professor Sedgwick†, being convinced that Mr. Marshall has rightly considered that limestone as the lowest bed of the Silurian system in this district‡, and in all his descriptions he adheres to the ascending order.

1st. *Coniston Limestone.*—It is doubtful whether this bed is continuous at its western extremity, or occurs only in detached patches. The two western portions of limestone at Water Blain and Low House are a mile and a quarter south of the bearing of the line of the bed east of the latter place, but are exactly on a line with the strike of the bed beyond Coniston; a great fault between Low house and Graystone House being counterbalanced by the whole of the smaller faults between that spot and Coniston, which are pointed out in Professor Sedgwick's memoir. Mr. Sharpe gives a list of fossils collected in this bed and the shales above it at Torver Fell, Coniston, Long Sleddale, &c., in which are several of the species of *Orthis*, *Spirifer*, and *Leptæna*, found by Mr. Murchison in the Lower Silurian deposits, and several undescribed species.

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† Geol. Trans. Second Series, vol. iv. p. 47.

‡ Report of the British Associaton, 1839, Sections, p. 67.

2nd. *Slates, Shales, and Flagstones.*—These are well exposed on Torver Fell, where the following series may be seen:—

a. Brown shale.

b. Dark blue slate of good quality; the beds dip E.S.E. 40°, and the cleavage dips S.S.E. 80°; it contains many fossils, much compressed and distorted, nevertheless a few Lower Silurian shells are made out.

c. Indurated brown shale.

d. Blue flagstone rock, a bed well known in the district, and mentioned by Professor Sedgwick and Mr. Marshall; at Torver, where it gives good roofing-slate as well as flags, the beds dip south-east 45°, and the cleavage south-east 80°. To the eastward of Windermere this bed and the lower bed of slate *b* run together, and the whole of the Lower Silurian formation diminishes in thickness.

e. Indurated shale.

f. Shear Bed, which supplies brownish-blue flags, taken along the bedding of the rocks, which is free from slaty cleavage.

This series of slates, flagstones, and shales, may be traced above the Coniston limestone from the Dudden to Shap Fells, although the separate beds cannot always be distinguished.

3rd. *Grey Slaty Grits,* described in Mr. Sharpe's former paper as the "Lower division of the Windermere rocks," but now classed as part of the Lower Silurian formation; they consist of a great thickness of hard gritty grauwacke, variously effected by cleavage, and may be traced from the Dudden, below Broughton, to Shap Fell.

4th. *Blawith Limestone,* "the second band of calcareous slate" of Professor Sedgwick; a bed only found in two localities, at Meer Beck and a wood behind Low Hall, on the east of the road from Ireleth to Kirkby Ireleth, where it is a dark-blue limestone very like that of Coniston, dipping east 40°, of which only about a thickness of twelve feet is laid open; and at Turtle-bank Heights, south-west of Blawith, where it has been quarried near the top of the south-east face of the hill, and is a dark gray limestone, twenty feet thick, striking north-east and dipping perpendicularly; from this spot it runs by Cockin's-hill to the side of Coniston Water, half a mile north of Water Gate. The fossils found by Mr. Marshall in this bed near Blawith were identified as Lower Silurian species.

5th. *Flagstones and Slates of Kikrby Ireleth.*—These are placed by Professor Sedgwick below the Blawith limestone, No. 4, but as Mr. Sharpe considers, erroneously: nevertheless, although no fossils have been found in them, he considers them to be the uppermost bed of the Lower Silurian series, because they are always conformable to the undoubted Lower Silurian beds below them, and are not equally conformable to the beds above. As this southern edge forms the boundary line of the Lower Silurian formation, Mr. Sharp traced them carefully along their whole course, from their first appearance rising from under the mountain limestone, on the east of Ireleth, till they are hidden by the old red sandstone of Birkbec-beck. Near Ireleth it is only used for building stone, but at Kirkby Ireleth are quarries extending for a mile and a half along the range of the bed, supply-dark-blue slates of very good quality. At Horse Spital Quarry the beds dip south-east 80°, and the cleavage dips south-east 55°, both sets of planes striking north-east: this coincidence in the strike of the bedding and cleavage planes is common in all this district; yet at Lord Quarry, close to the last-mentioned, the beds dip N.N.E. 20°, while the cleavage dips S.SE. 70°. Further east the rock is of inferior quality, and is rarely worked for roofing slate: its usual course is north-east passing by Suberthwaite, Blawith, Nibthwaite, at the foot of Coniston Water, where much building stone has been quarried, and the rock is well exposed, being a dark-blue flagstone streaked with gray: between

Oxen Park and Satterthwaite it dips north 50°, and N.N.W. 70°, and is lighter and more striped than usual; at Force Mill it strikes E.N.E. aud dips N.N.W. 65°, and the cleavage has the same strike but is perpendicular: at Satterthwaite the dip is north 45° : between Esthwaite and the Ferry on Windermere the road runs near the upper edge of the bed, which is well exposed close to the Ferry House, north of which spot it reaches more than a mile up the shore of the lake. On the east side of the lake it has been quarried north of Bowness.

Eastward of Bowness, Mr. Sharpe corrects an error which he committed in laying down this line too far south : he now traces it nearly E.N.E. by Ing's Chapel, Row Gill, and Hughill Hall, dip south-east 60°; Monument Hill on the west side of Kentmere, dip S.S.E. 80° to Fellfoot in Kentmere. The flagstone crosses Long Sleddale at the Chapel, where it was found not worth working for slate : at Bonnisdale-head Farm it gives a slate of fair quality, the beds dip south-east by south 65°, and the cleavage dips in the some direction 80°, from here it crosses into High Borrowdale half a mile above High House, dipping south-east by south 50°, a fault down this valley throws the bed below High House on the east side of the valley: in the next Fells it is much concealed by the vegetation, but it is seen at a cutting of the road from Shap to Kendal on Hurd's Brow, between the ninth and tenth mile-stone, dipping south-east 75°, and the cleavage dipping north-west 85°. Near the Borrow the beds are thrown into several anticlinal ridges bearing north-east, by faults which disturb the cleavage planes as well as the bedding of the rock: this slate has also been worked in the upper part of Bretherdale. The boundary thus laid down nearly corresponds with that given in the new edition of Mr. Greenough's map.

The lowest beds of the slate in High Borrowdale are calcareous, and may perhaps present the Blawith limestone, which has not been found in conjunction with the slate eastward of Blawith.

In High Furness, the district of Lancashire consisting of

Lower Silurian rocks, the principal valleys run from south-west to north-east, parallel to the strike of the beds, each ridge of hills representing the outcrop of a particular bed : this is not the case with the same formation in Westmoreland, where the valleys of Coniston Water, Esthwaite, Windermere, Troutbulk, Kentmere, Long Sleddale, Bannisdale, High Borrowdale, and Brethesdale, all follow great faults across the strike of the stratification : these faults are continued through the Windermere rocks, and sometimes into the Lower Ludlow rocks, but are lost before entering the Upper Ludlows.

It is in High Furness that the Lower Silurian formation is best exposed to observation, and has a greater thickness than in Westmoreland, the beds gradually diminishing in their course eastward. In the same district of Lancashire the slaty character of the rocks is more developed than we find it in Westmoreland ; it is especially between Coniston, Old Mere and Kirkby Ireleth, that the crystallizing agency which has changed the rocks into slate has acted most powerfully, many beds in that district supplying good slate, which will hardly split up at all elsewhere.

From the prevailing parallelism long known to exist between the planes of slaty cleavage over considerable areas, Mr. Sharpe considers it nearly certain that these planes had a uniform direction in each district, and that the cases of exceptions which are found, are due to disturbing forces acting after the cessation of the cleavage action. In the district under consideration the mean dip of the cleavage planes is considered to be S.S.E. 70°, and the cleavage action is thought to have ceased before the formation of the Upper Ludlow rocks.

Windermere Rocks.—The beds formerly classed by the author as the lowest division of this series are now placed in the Lower Silurian formation, and the middle and upper divisions are thrown together, for want of any distinct line of division between them, and some considerable corrections are made in their geographical boundaries. They rise, near Ulverston, from below the mountain limestone of Low Furness, dipping E.S.E. at high angles, and disappear in Westmoreland beyond Bannisdale, during which course they rest on the Kirkby Ireleth slate; but their southern boundary can only be understood from the map, as to the west of Windermere they are overlaid by large patches of mountain limestone, and in their range eastward are gradually covered up uncomformably, and concealed by the Lower Ludlow rocks. In some places the similarity of the rocks of the two formations, and the absence of fossils in both, makes it difficult to determine the boundary between them, the best guide being the dip and strike of the rocks. In Mr. Sharpe's first map a portion of the Lower Ludlow rocks on the north-east of Kendal was erroneously coloured as belonging to the Windermere series; the error was pointed out by Cornelius Nicholson, Esq., of Cowan Head, who assisted the author materially in mapping the neighbourhood of his residence.

The upper boundary of the Windermere rocks begins on the south-west at the lower point of Witherslack, and is marked by a great fault which crosses the valley between that hill and Whitbarrow, and appears to pass under the mountain limestone of Whitbarrow, then runs north-east through Underbarrow, by the Chapel, to Mountjoy: on the west side of this fault the Windermere rocks form high ridges of hard slaty grits of dark grey colour, with lighter streaks, dipping N.N.W., while on the east side of the fault is a gritty rock of uniform grey colour dipping E.S.E., overlaid with beds containing the fossils of the Ludlow beds. From Mountjoy the line turns to the north-west, and passes round Crook Chapel, which stands on a ridge of the Windermere grits; at Crock Common it turns to the north-east, and follows that direction to near Borrowdale, where the formation is lost, being completely hidden by Ludlow rocks, which there rest on the Lower Silurians. Crook Common is thrown into great confusion by the meeting of two lines of elevation, one coinciding with the N.N.W. through Cartmel Fell.

At Backbarrow, below Newby Bridge, the upper beds of this series are slaty, with a wavy cleavage dipping N.N.E. 80°, the beds dipping south-east 80°; these beds contain irregular calcareous nodules in great abundance, and *Orthoceras articulatum* was found in them.

Mr. Sharpe refers to his former memoir for the description of the Windermere rocks on the east of the Lune, which extend to Greyrigg Forest, Whin Fell, and Howgill Fell; in these Fells are several axes of elevation which require further examination.

Ludlow Rocks:—These were described in the author's former paper; the area covered by them is larger than was there stated; their lower boundary being now carried more to the north, and their eastern portion being extended in a sort of trough between the Lower Silurian slates of Shap Fell and the Windermere rocks of Whin Fell, crossing Barrowdale between High and Low Barrowbridge.

In the lowest beds of the series in Fawcett Forest were found *Lapiæna lata* and *Turritella conica*, in a slaty rock. The *Terebratula navicula* is found thinly scattered throughout all the lower part of the formation, and occurs in vast numbers in a bed which forms about the middle of the Ludlow series. Mr. Murchison has told us that this little shell is usually found in such numbers as to form a bed which lies above the Aymestry limestone, and it serves to mark the place of that rock where it is wanting: and Mr. J. E. Davis informed the author, that at Stapleton near Presteign, where there is no Aymestry limestone, this species is found throughout the whole of the Lower Ludlow shales. Mr. Sharpe has made use of this shell in dividing the Upper from the Lower Ludlow rocks in Westmoreland, classing all the beds containing it in the lower series. The bed in which it occurs in greater abundance was traced through Underbarrow, by Tullithwaite Hall and High Cray, across the west end of Rather Heath and little south of Cowan Head, and also in Lambrigg Park; it is usually accompanied by *Atrypa affinis*, *Spirifer octoplicatus*, *Meptæna lata* and *depressa, Orthis lunata,* and *Terebratula nucula:* the *T. navicula* seems to have died out suddenly, as it is not found in the Upper Ludlow beds.

The same division of the Ludlow rocks may be obtained by attending to the direction and dip of the beds; the lower series partakes of the north-east strike, which runs through the older Silurian rocks in these counties, and is traversed by many of the same faults as those formations, but the Upper Ludlow beds are thrown up in anticlinal ridges with a different direction.

Mr. Sharpe gives a list of the organic remains found in each division of the formation, which includes forty-four of the species described in Mr. Murchison's work from the old red sandstone and Upper Ludlow, fourteen of those from the Aymestry limestone, and twenty-two of those from the Lower Ludlow beds. Of the species of shells placed by Mr Murchison in the old red sandstone *, all but two have now been found in the Ludlow beds, proving that the red beds containing these species in Herefordshire must be classed with the Upper Ludlow formation.

Old Red Sandstone.—The only addition to the former paper which relates to this formation, is in mapping it in the upper valley of the Lune, where the tile-stones reach above the hamlet of Langdale, dipping N.N.E. 10°.

The age of the large masses of gravel of a brown and red colour noticed in the valley of the Lune between Sedberg and Casterton, and of the Kent and Sprint, was before left uncertain; the author now regards them as a modern surface drift.

Mountain Limestone.—The description of this formation did not enter into Mr. Sharpe's plan but he examined the portion of it which occurs in Low Furness, to ascertain the geological position of the Ulverston iron ore.

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* Silurian System, p. 603, and t. 3.

The ore occurs in veins usually perpendicular, and bearing W.N.W., which cut through the limestone, but are not continued into the Siluarian rocks. The following veins are mentioned :—

Plumpton Hall; now abandoned.

Lindal More vein; an exception to the usual condition, as it runs between the mountain limestone and the Windermere grits, striking north-west and dipping south-west 45°; it is the principal and most profitable vein of the district.

Stainton; three veins separated by a few yards of clay, spar, and limestone, perpendicular, and bearing W.N.W.

Lindal Court; several perpendicular veins near together, bearing W.N.W.

Crosthwaite; a poor vein bearing W.N.W., thought to be the continuation of that at Stainton.

Wet Flat; the rocks near are much disturbed, and the vein, after running W.N.W., turns down a fault in the limestone to N.N.W., but soon this thins out.

Trap Rocks.—These are rare in the district; Professor Sedgwick has laid down some masses of igneous rocks at Shap Fells, on the south side of the high road; one of them consists of red felspar with some mica, quartz, and hornblende. The slate rocks are much disturbed in the neighbourhood, and the faults have broken up the cleavage planes as well as the bedding of the rocks, from which Mr. Sharpe infers that the trap is more modern than the eruption of the Shap granite, which took place before the cleaving of the slates, as the cleavage planes run through all the faults connected with that eruption.

At Biglands, south of Newby Bridge, there is a trap dyke running north-east, which has also disturbed the parallelism of the cleavage, and must be considered as of a modern date: it is not well exposed on the surface.

The author concludes by a comparison of all the beds with those described by Mr. Murchison in the border counties of

Wales, and adopted as the types of the Silurian system, and with those of Denbighshire and Merionethshire, to which his attention was directed by Mr. Bowman's papers on Langollen; he points out the closest resemblance between the Silurian formation in North Wales and in Westmoreland, while in mineral character they differ most materially from those of Siluria: nevertheless the principal divisions of the Silurian system laid down by Mr. Murchison can be traced in each district by the evidence of the organic remains.

"On the Stratified Rocks of Berwickshire and their Organic Remains." By Mr. William Stevenson, of Dunse.

1. In this memoir the author gives an account of the characteristic features, the order of succession, and the nature of the inorganic remains of the stratified rocks of Berwickshire. The lowest of these are greywacke and greywacke slate, forming an extensive system of arenaceous and argillaceous strata of various colours, gray predominating, found almost everywhere among the Lammermuirs, of which chain they constitute the fundamental rock. In the rocks of this system no undoubted organic remains have been found, but some curious markings occur on the slabs, for which it is difficult to account without supposing the influence of organic agency. The greywacke presents the uniform appearance of a deep sea deposit, perhaps laid down upon the bottom of a wide spreading ocean of great profundity, and therefore removed from the disturbing action of wind and tide. The thickness of these strata, as displayed among the Lammermuirs, is very great, but the series is far from being complete, there being no appearance of the older strata on the one hand, and on the other their junction with the newer formation is always unconformable. The materials of which they are composed were probably derived from the disintegration of the granites and primary schists to the west-ward.

2. The formation next in order is the upper division of the old red sandstone, the members of which rest unconformably upon

the upturned ends of the greywacke. The lowest member of it is an old red sandstone conglomerate, consisting of fragments of greywacke and felspathic rocks, cemented by a paste which is generally arenaceous, sometimes calcareous. It varies much in thickness.

3. Red and greenish white sandstones succeed with soft red argillaceous strata. Part of these seem to have been formed in a shallow sea, since they exhibit ripple marks, and contain *Holoptychius* and *Dendrodus*. Another portion contains few traces of fossils, and was probably deposited in deeper water. Some curious spindle-shaped concretions and the impressions called "Kelpie's feet" occur, also traces of *fuci*. Two localities near Preston-Haugh, and one at the foot of the Knock-hill, are all in which organic remains have yet been found.

4. After the deposition of the strata containing the remains of the *Holoptychius*, &c., a subsidence to a considerable extent took place, after which a succession of strata of great thickness was deposited above them. These rocks seem to have been formed in deeper water than the ichthyolitic beds. They consist of red and greenish white sandstones interstratified with beds of a softer and more argillaceous character, and of a deep red colour. They seem to contain no organic remains except vegetable impressions (Algæ?) which occur in abundance in a bed of red sandstone perhaps 100 feet above the strata containing the animal remains.

5. Above the soft red and white sandstone are calcareous shales, sandstones and cornstones, or impure concretionary limestones without fossils. The junction of these with the sandstones is not seen, being cut off by faults and trap dykes.

6. The lower portion of the coal measures succeeds, consisting of shales, marls, clays, and sandstones containing ironstone bands and gypsum, and abounding in vegetable fossils, consisting of *Coniferæ*, *Stigmariæ*, *Lepidodendra*, and other coal plants. This formation is well developed over the greater part of the

Mers of Berwickshire.

7. Next in order are some thick beds of reddish sandstone, underlying

8. Carboniferous strata, consisting of sandstone, shales &c., including three or four coal-seams.

9. The encrinal limestone, seen a litle north of Berwick.

Mr Stevenson remarks that the Berwickshire carboniferous strata appears to correspond with the lower beds of the Fife and Lothian coal-fields, considered by Mr. Milne and others to belong to the mountain limestone, and to be considerably lower than the Newcastle coal strata. With regard to the inquiry whether new red sandstone exists in Berwickshire, Mr. Stevenson is inclined to answer it in the negative. He regards the beds at Cumledge, described by Mr. Milne as such, as old red, and considers the soft red clays and sands at Lintlaw, derived from the disintegration of the old red sandstone, referred by Mr. Milne to the new red sandstone, to be of undetermined age, from want of sufficient evidence in the absence of organic remains. The exact position of the greywacke strata of the Lammermuirs is for the same reason indeterminate. The author concludes by pointing out the great gap which occurs between the greywacke and the upper division of the old red sandstone in Berwickshire, the middle and lower divisions of the old red and the whole of the Silurian system being deficient. Another circumstance worthy of remark is the absence of any formations more recent than the coal-measures, if we except alluvial deposits and the undetermined red strata formerly mentioned.

Feb. 1*st*, 1843. The President, in the chair. A paper was read " *On the Tertiary Strata of the Island of Martha's Vineyard in Massachusetts.*" By Charles Lyell Esq., V.P.G.S., &c.

The most northern limit to which the tertiary strata bordering the Atlantic have been traced in the United States is in Massachusets in Martha's Vineyard, lat. 41° 20′ north, an island about twenty miles in length from east to west, and about ten from north to south, and rising to the height of between 200 and 300 feet above the sea. The tertiary strata of this island are, for the most part, deeply buried beneath a mass of drift, in which lie huge erratic blocks of granite and other rocks which appear to have come from the north, probably from the mountains of New Hampshire. The tertiary consist of white and green sands, a conglomerate, white, blue, yellow, and blood-red clays and black layers of lignite, all inclined at a high angle to the north-east, and in some of their curves quite vertical. They are finely exposed near Whilmark on the south-west side of the island, and in the promontory of Gay Head at its south-western extremity, where there is a vertical section of more than 200 feet in height.

Attention was first called to this formation by Prof. Hitchcock in 1823, who appears to be the only American geologist who has examined it personally. He compared the beds at Gay Head to the plastic and London clays of Alum Bay in the Isle of Wight, to which lithologically, they bear a striking resemblance, consisting in both cases of variously and brightly coloured clays and sands with lignite, all incoherent and highly inclined. Various opinions, however, have been put forth as to the relative age of the Martha's Vineyard strata which were assigned by Prof. Hitchcock, at a time when the tertiary formations of the United States were less known, to the Eocene period, while Dr. Morton supposed them to be in part only tertiary, and that they rested on greensand of the cretaceous period. The section at Gay Head is continuous for four fifths of a mile, the beds dip to the north-east generally at an angle of from thirty-five to fifty degrees, though in some places at seventy degrees. The clays predominate over the sands. In one place Mr. Lyell found a great fold in the beds, in which the same osseous conglomerate and associated beds of white sand, on the whole fifty feet thick, were so bent as to have twice a north-easterly and once a south-westerly dip. In the yellowish and dark brown clay near the uppermost part of the section at Gay Head, and in the green sand immediately resting upon it *, Mr. Lyell found the teeth of a shark, that of a seal, vertebræ of cetacea, crustacean remains, and casts of *Tellina* and *Mya*. These prevail at intervals through a thickness of nearly 100 feet, and are followed by beds of sand and clay with lignite. Mr. Lyell found no remains in the red clays. Many rolled bones were found in the osseous conglomerate.

In the section at Chilmark similar strata to those at Gay Head occur, but the general dip is south-west. Some of the folds, however, give anticlinal dips to the north-east as well as the south-west, and there are many irregularities, the beds being sometimes vertical and twisted in every direction. Several faults are seen, and veins of iron-sand, which intersect the strata like narrow dykes, as if there had been cracks filled from above. One bed of osseous conglomerate at Chilmark, four yards in thickness, is vertical, and its strike is well seen to be north 25° so that the disturbances have evidently been so great that it would be difficult without more sections to determine positively the prevailing strike of these beds. The incumbent drift is very variable in thickness, and large erratic blocks, from twenty to thirty feet in diameter, are seen resting on quartzose sand. The author saw no grounds for concluding that any cretaceous strata occur anywhere in the island, nor could he find any fossils which appeared to have been washed out of a cretaceous formation into the tertiary strata, as some have suggested.

Mr. Lyell proceeds to the consideration of the organic remains collected by himself in Martha's Vineyard.

Mammalia.—1. A tooth, identified by Prof. Owen as the canine tooth of a seal, of which the crown is fractured. It seems nearly allied to the modern *Cystophora proboscidea*.

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* Nos. 5 and 6 of Prof. Hitchcock's section.

2. A skull of a walrus, differing from the skulls of the existing species (*Lrichecus rosmarus,* Linn.), with which it was compared by Prof. Owen, in having only six molars and two tusks, whereas those of the recent have four molars on each side, besides occasionally a rudimentary one. The front tusk is rounder than that of the recent walrus.

3. Vertebræ of *Cetacea,* some of which are referred by Prof. Owen to the whalebone-whales, and others to the bottle-nosed (*Hyperoodon*).

Pisces.—Teeth of sharks resembling species from the Faluns of Touraine, viz. *Carcharias megaladon, Oxyrhina xiphodon, O. hastulis,* and *Lamna cuspidata.* With these were large teeth of two species of *Carcharias,* one resembling *C. productus,* a Maltese fossil. With the exception of the two last, Mr. Lyell found the same species in miocene strata near Evergreen, on the right bank of James River in Virginia.

Crustacea.—A species considered by Mr. Adam White as probably belonging to the genus *Cyclograpsus,* or the closely allied *Sesarma* of Say, and another, decidedly a *Geyarcinus.*

Mollusca.—1. Casts of a *Tellina* allied to *T. biplicata,* a miocene fossil, and of another near *T. lusoria.* 2. Cast of a *Cytherea* resembling *C. Sayana,* Conrad. 3. Three casts of a *Mya,* one of which bears a close resemblance to *Mya truncata.*

Mr. Lyell concludes, from the various evidences here given, that the strata of Martha's Vineyard are miocene. The numerous remains of Cetacea of the genera *Balæna* and *Hyperoodon* are adverse to the supposition of their being Eocene, while such fossils abound in the miocene beds of America. The other fossils all point to a similar conclusion.

Letter from J. Hamilton Cooper, Esq., to Charles Lyell, Esq., V.P.G.S., "*On Fossil bones found in digging the New Bruniwick Canal in Georgia.*"

Mr. Cooper prefaces his communication by a description of the country surrounding the locality in which the bones were found. The portion described is that part of the sea-coast of Georgia which lies between the Alatamaha and Turtle rivers in one direction, and the Atlantic Ocean and the head of tide water on the other. For twenty miles inland the land is low, averaging a height of from ten to twenty feet, and reaching, in some instances, forty feet, and consisting of swamps, salt-marshes, sandy land, and clay loam. It then suddenly rises to the height of seventy feet, and runs back west at this elevation about twenty miles, at which point there is a similar elevation of between sixty and seventy feet. The whole of this district is a post-tertiary formation, and is composed of recent alluvium, and a well-characterized marine post-pliocene deposit. The recent alluvium is divided into inland-swamp, tide-swamp, and salt-marsh. The two last occupy a shallow basin, having a depth of about two feet, the bottom and sides of which are the post-pliocene formation. This the author divides into three groups, in the last of which, constituting the elevated sand hills, no organic remains have been found; in the two former marine shells of existing species occur.

The fossil bones of the land mammalia discovered by Mr. Cooper, were found resting on the yellow sand and enveloped in the recent clay alluvium. Their unworn state and the grouping together of many bones of the same skeleton, render it highly probable that the carcases of the animals falling or floating into a former lake or stream, sank to the sandy bottom, and were gradually covered to their present depth by the sedimentary deposits from the water. Among them were remains of the Megatherium, *Mastodon giganteum*, mammoth, hippopotamus and horse. The fossil shells found in the post-pliocene, were species at present existing on the neighbouring shores.

The facts narrated by Mr. Cooper lead to the following conclusions:—1st. That the post-pliocene formation extends further south than Maryland, to which it has hitherto been limited.

2nd. The co-existence of the megatherium with the mammoth, mastodon, horse, bison, and hippopotamus. 3rd. That the surface of the country has undergone no sudden or violent change since those animals inhabited it, which is proved by the absence of all traces of diluvial action in the enveloping alluvium or surrounding country. 4th. That whatever changes of temperature may have taken place since that time, fatal to the existence of those mammalia, the identity of the fossil with the existing species of the marine shells of the coast shows that the temperature of the ocean at a period prior to the existence of the megatherium, the mastodon, and the hippopotamus, was such as is congenial to the present marine testacea of Georgia.

"*Description of some Fossil Fruits from the Chalk-formation of the South-east of England.*" By Dr. Mantell, F.R.S., &c.

The fruits described are three in number, viz.—

1. *Zamia Sussexiensis*, Mantell.—From the greensand. A cone allied to the *Zamia macrocephala*, a greensand fossil from Kent, figured in Lindley and Hutton's 'Fossil Flora,' pl. 125, from which it differs in form and in the number, size, and shape of its scales, which are more numerous, smaller, and more oblong than in the Kentish species. It is five inches long, and at the greatest circumference measures six inches. It was found abound two years ago in an accumulation of fossil coniferous wood in a sand-bank at Selmeston, Sussex, at the junction of the Shanklin sand with the gault. Dr. Mantell having sent a cast of the only specimen found to M. Adolphe Brongniart, that distinguished botanist suggested that it might be either the stem of a young cycadaceous plant or the fruit of a *Zamia*, but the situation and small size of the stalk at the base, and the appearance of the scales, induce Dr. Mantell to refer it to the latter.

2. *Abies Benstedi*, Mantell.—From the greensand near Maidstone, Kent. A beautiful cone found by Mr. W. H. Bensted in

the quarry in which the remains of the Iguanodon were discovered in 1834, where it was associated with *Fucus Targionii*, and some indeterminate species of the same genus; stems and apparently traces of the foliage of endogenous trees allied to the *Eracæna* (*Sternbergia*), and of trunks and branches of *Coniferæ*. The wood occurs both in a calcareous and silicious state. The cone found is in every respect such a fruit as the trees, to which the wood belonged, might have borne. It bears a close resemblance to a fossil from the greensand of Dorsetshire, discovered by Dr. Buckland, and figured in the 'Fossil Flora' of Great Britain under the name of *Abies oblonga* (Fos. Fl. pl. 1.). Unfortunately the outer surface is so much worn that the external figure of the scales cannot be accurately defined; but the sections show their proportionate thickness. There is an opening at the base of the cone occasioned by the removal of the stalk, and an accidental oblique fracture exhibits the internal structure. In the longitudinal section thus exposed the scales are seen to be rounded and broad at their base and to rise gradually, and become thin at their outer terminations. The seeds are oblong, and one seed is seen imbedded within the base of each scale. Mr. Morris considers it to have a great affinity to *Abies oblonga* of Lindley and Hutton, but it is more spherical, and the scales are smaller, more regular, and numerous.

3. *Carpolithes Smithiæ*, Mantell.—From the white chalk of Kent. An account of an imperfect specimen of this fruit was formerly given by Dr. Mantell in his 'Illustrations of the Geology of Sussex.' He lately detected a second and more perfect example in the choice collection of Mrs. Smith of Tunbridge Wells, in honour of whom he has named it. Dr. Mantell remarks, that a slight inspection was sufficient to determine its vegetable origin, for several seeds were imbedded in its substance, and others had been detached in clearing it from the chalk. Dr. Robert Brown suggested that the original was probably a succulent compound berry, the seeds appearing to have been imbed-

ded in a pulpy substance like the fruit of the mulberry, which is a spurious compound berry, formed by a partial union of the enlarged and fleshy calices, each inclosing a dry membraneous pericarp.

From the occurrence of the cones above described with the drifted remains of land and fresh water reptiles peculiar to the Wealden, Dr. Mantell infers that these fruits belong to the flora of the country of the country of the *Iguanodon.*

"*Notice on the fossilized remains of the soft parts of Mollusca,*" by Dr. Mantell, F.R.S., &c.

Substances presenting the same general appearance and composition with coprolites, but destitute of the spiral structure, are thickly interspersed among the shells which abound in the rocks of firestone or upper greensand at Southborne in Sussex, sometimes occurring in the state of casts of shells of the genera *Cucullæa, Venus, Trochus, Rostellaria,* &c., from the soft bodies of which testacea Dr. Mantell considers them to have originated. They abound also in the layers of firestone which form the line of junction with the gault, and are not uncommon in the gault itself in several localities in Surrey and Kent.

Dr. Fitton, in his memoir 'On the Strata below the Chalk' (Geol. Trans. vol. iv. part 2, p. 11), has given an account of similar concretions from Folkstone, where he observed them in some cases surrounding or incorporated with fossil remains, and filling the interior of Ammonites. Dr. Mantell has observed them also in the Shanklin sand in Western Sussex, in Surrey, near Ventnor in the Isle of Wight, and in Kent, and they especially abound in the Iguanodon quarry of Kentish rag near Maidstone, belonging to Mr. W. H. Bensted.

Mr. Bensted having long paid attention to this subject, more than two years ago submitted to Dr. Mantell specimens of fossil shells, the cavities of which were filled with a dark brown substance in every respect identical with the nodular and irregular concretions of coprolitic matter which abound in the surrounding sandstone. Mr. Bensted expressed his belief that the carbonaceous substance was derived from the soft bodies of the Mollusca, and that the concretionary and amorphous portions of the same matter dispersed throughout the sandstone of this bed, were masses of the fossilized bodies of the animals which had become disengaged from their shells, and had floated in the sea till enveloped in the sand and mud, which is now concreted to the coarse sandstone called Kentish rag. In proof of this opinion, reference is made to an account published in the 'American Journal of Science' for 1837, of the effects of an epidemic among the shell-fish of the Ohio, which, killing the animals, their decomposed bodies rose to the surface of the water, leaving the shells in the bed of the stream, and, floating away, covered the banks of the river. Mr. Bensted points out that nearly the whole of the shells in the Kentish rag of his quarry appear to have been dead shells, and infers that their death might have been owing to a similar cause with that which destroyed the *Uniones* in America; while their bodies intermingling with the drift wood on a sand bank, furnished the concretions described in this communication.

The Rev. J. B. Reade submitted some of the substances of these bodies to an analysis by Mr. Rigg, who confirmed Dr. Mantell's suspicion of the presence of animal carbon in it, and states that the darker portion of the substance contains about 35 per cent. of its weight of carbon in an organized state.

Dr. Mantell adds, that a microscopical examination with a low power detects innumerable portions of the periosteum and nacreous laminæ of the shells of extreme thinness intermingled with the carbonaceous matter, together with numerous siliceous spiculæ of sponges, very minute spines of *Echinodermata,* and fragments of *Polyparia,* and remarks that these extraneous bodies probably became intermingled among the soft animal mass before the latter had undergone decomposition. He proposes to term the substance *Molluskite,* and states that it constitutes the dark spots and markings in the Sussex and Purbeck marbles.

" On the Geological position of the Mastodon giganteum and associated fossil remains at Bigbone Lick, Kentucky, and other localities in the United States and Canada." By Charles Lyell, Esq., V.P.G.S.

With a view to ascertain the relations of the soil in which the bones of the Mastodon are found, to the drift or boulder formation, whether any important geographical or geological changes had taken place since they were imbedded, and what species of shells are associated with them, Mr. Lyell visited a number of places where they had been obtained. In this paper he gives the result of his researches.

The most celebrated locality visited was Bigbone Lick, in the northern part of Kentucky, distant about 25 miles to the S.W. of Cincinnati, situated on a small tributary of the river Ohio called Bigbone Creek, which winds for about 7 miles below the Lick before joining the Ohio. A "Lick" is a place where saline springs break out, generally among marshes and bogs, to which deer, buffaloes, and other wild animals resort to drink the brackish water and lick the salt in summer. The country around Bigbone Lick, and for a considerable distance on both banks of the Ohio, above and below it, is composed of blue argillaceous limestone and marl, constituting one of the oldest members of of the transition or Silurian system. The strata are nearly horizontal and form flat table-lands intersected by numerous valleys in which alluvial gravel and silt occur; but there is no covering of drift in this region. The drift is abundant in the northern parts of Ohio and Indiana, but disappears almost entirely before we reach the Ohio.

Until lately herds of buffaloes were in the habit of frequenting the springs, and the paths made by them are still to be seen. Numbers of these animals have been mired in the bogs, and horses and cows have perished in like manner. Along with their remains are found innumerable bones of Mastodon, Elephant, and other extinct quadrupeds, which must have visited these springs when the valley was in its present geographical condition in almost every particular, and which must have been mired in them as existing quadrupeds are at present. The mastodon remains are most numerous, and belong to individuals of all ages. The mud is very deep, black, and soft. In places it is seen to rest upon the limestone, and at some points it swells up to the height of several feet above the general level of the plain and of the river. It is occasionally covered by a deposit of yellow clay or loam, resembling the silt of the Ohio, which is from ten to twenty feet thick, rising to that height above the creek and often terminating abruptly at its edges. This loam has all the appearance of having been deposited tranquilly on the surface of the morass and of having afterwards suffered denudation. The Mastodon and other quadrupeds have been mired before the deposition of the incumbent silt, for a considerable number of fossil bones have been found by digging through it. Accompanying the bones are freshwater and land shells, most of which have been identified by Mr. Anthony with species now existing in the same region.

Mr. Lyell observes that the surface of the bog is extremely uneven, and accounts for it partly by the unequal distribution of the incumbent alluvium which presses with a heavy weight on certain parts of the morass, from which other portions of the surface are entirely free. He also attributes it in part to the swelling of the bog where it is fully saturated with water near the springs.

The author is of opinion that the fossil remains of Bigbone Lick are much more modern than the deposition of the drift, which is not present in this district. But although the date of the imbedding of these mammalian fossil remains is so extremely modern, considered geologically, it is impossible to say how many thousand years may not have elapsed since the Mastodon and other lost species became extinct. They have been found at the depth of several feet from the surface, but we have no data for estimating the rate at which the boggy ground has increased in height, nor do we know how often during floods its upper portion has been swept away.

Ohio.—The Ohio river immediately above and below Cincinnati is bounded on its right bank by two terraces consisting of sand, gravel and loam, the lower terrace consisting of beds supposed to be much newer than those of the upper. In the gravelly beds of the higher terrace teeth, both of the Mastodon and Elephant, have been met with. Mr. Lyell was assured that a boulder of gneiss, 12 feet in diameter, was resting on the upper terrace, about 4 miles north of Cincinnati, and that some fragments of granite had been found in a similar situation at Cincinnati itself. These facts show that some large erratics have taken up their present position since the older alluvium of the Ohio valley was deposited. In travelling northwards from Cincinnati towards Cleveland, Mr. Lyell found the northern drift commence in partial patches 25 miles from the former city and about 5 miles N. E. of Lebannon, after which it continually increased in thickness as he proceeded towards Lake Erie.

New York—Niagara Falls.—In a former paper Mr. Lyell alluded to the position of the remains of Mastodon 12 feet deep, in a fresh water formation on the right bank of the river Niagara, at the Falls. He remarks that if we had not been able to prove that the cataract had receded nearly four miles since the origin of the fluviatile strata in question, we should have been unable to assign any considerable duration of time as having intervened between the inhumation of the Mastodon, in marl full of existing shells and the present period. The general covering of drift between Lakes Erie and Ontario is considered to be of much higher antiquity than the gravel containing the bones of the Mastodon at the Falls.

Rochester.—In the suburbs of this city remains of the *Mastodon giganteum* were found associated with existing species of Mollusca in gravel and marl below peat.

Genesee.—Here remains of the *Mastodon giganteum* were found with existing shells, in a small swamp in a cavity of the boulder formation, so that the animal must have sunk after the period of the drift, when a shallow pond fed by springs was inhabited by the same species of freshwater mollusca as now live on the spot.

Albany and Greene Counties.—Mr. Lyell examined, in company with Mr. Hall, two swamps west of the Hudson River, where the remains of Mastodon occurred in both places at a depth of four or five feet, precisely in such situations as would yield shell marl, and peat, with remains of existing animals in Scotland. Cattle have recently been mired in these swamps.

According to Mr. Hall the greatest elevation at which Mastodon bones have been found in the United Srates is at the town of Hinsdale, situated on a tributary of the river Allegany in Cattaraugus county in the State of New York, where they occur at an elevation of 1500 feet above the level of the sea.

Maryland.—In the museum at Baltimore, Mr. Lyell was shown the grinder of a Mastodon, distinct from *M. giganteum,* and which had been recognised and labelled by Mr. Charlesworth as *M. longirostris,* Kaup. It was found at the depth of 15 feet from the surface in a bed of marl near Greensburgh, in Carolina County, Maryland, and is considered by Mr. Lyell as a miocene fossil.

Atlantic border.—Between the Appalachian mountains and the Atlantic there is a wide extent of nearly horizontal tertiary strata, which at the base of the mountains are 500 feet and upwards in height, but decline in level nearer the ocean and at length give place to sandy plains and low islands skirting the coast, in which, strata, containing marine shells of recent species, are met with, slightly elevated above the sea. Occasionally deposits formed in freshwater swamps occur, below the mean level of the Atlantic or overflowed at high tide. In this district Mr. Nuttall discovered, on the Neuse 15 miles below Newburn, in South Carolina, a large assemblage of mammalian bones, including those of the *Mastodon giganteum*, resting on a deposit containing marine shells of recent species. Mr. Conrad presented Mr. Lyell with the tooth of a horse covered with barnacles, from this locality. Professor Owen has examined it and could find no corresponding tooth of a recent species, but considers it as agreeing with the horse-tooth brought by Mr. Darwin from the north side of the Plata in Entre Rios in South America.

South Carolina.—Remains of the Mastodon were found in digging the Santee Canal, in a spot where large quadrupeds might now sink into the soft boggy ground.

Georgia.—Bones of the Mastodon and Megatherium occur in this district in swamps formed upon a marine sand containing shells of species now inhabiting the neighbouring sea.

Mr. Lyell in conclusion offers the following observations :—

1. That the extinct animals of Bigbone Lick and those of the Atlantic border in the Carolinas and in Georgia belonging to the same group, the identical species of Mastodon and elephant being in both cases associated with the horse, and while we have the Mylodon and Megatherium in Georgia, the Megalonyx is stated by several authors to have been found at Bigbone Lick.

2. On both sides of the Appalachian chain, the fossil shells, whether land or freshwater, accompanying the bones of Mastodons, agree with species of Mollusca now inhabiting the same regions.

3. Under similar circumstances Mr. Darwin found the Mastodon and horse in Entre Rios, near the Plata, and the Megath-

erium, Megalonyx and Mylodon, together with the horse, in Bahia Blanca in Patagonia; these South American remains being shown by their geological position to be of later date than certain marine Newer Pliocene, and Post-pliocene strata. Mr. Darwin also ascertained that some extinct animals of the same group are more modern in Patagonia than the drift with erratics.

4. The extinct quadrupeds before alluded to in the United States lived after the deposition of the northern drift, and consequently the coldness of the climate which probably coincided in date with the transportation of the drift, was not, as some pretend, the cause of their extinction.

MANCHESTER GEOLOGICAL SOCIETY.

Feb. 23rd.—Dr. Black, F.G.S. read his paper "*On the Submerged Forests of Great Britain.*"

After a few preliminary remarks on the various remains of the vegetable world which once flourished in this island, and which are now found entombed within the strata of the earth,—the writer went on to state the mode in which the geologist of the present day had arrived at a knowledge of that great herbarium which has lain undisturbed so long in its present position. He remarked that the superficial covering of sand, clay, or gravel which had formerly been the basis of vegetable life and growth within the historical age of man, was not entirely perfect. In many places the seal was broken asunder, or altogether torn away; so that the remains of the vegetable world, of what might be called the middle age of the earth, were disclosed to view, both in the more inland districts and along many of the shores of this island, from the Hebrides to the Land's End. The author then gave a brief notice of the principal submarine forests which have been found on the shores of the islands and western coast of Scotland, round to those very extensive submerged forests on the coasts of Lincolnshire and Yorkshire, and finally, noticing those which have been found on the Friths of the Forth and the Tay. With regard to the *flora* of these submerged beds, he remarked that they presented an assemblage of nearly the same species of forest trees and plants as those which now exist on the surface of the earth, although, in many places, differing widely from the present vegetable products of the localities in which they are found; as, for example, in the Western Isles of Scotland, where large forest trees are found submerged beneath a soil which seems incapable of producing anything of the same magnitude at the present day. So far as he had been able to learn, no remains of the palm, nor indeed of any tropical, or even of any marine, plant, had ever been found in the forest beds of Great Britain. One very constant and characteristic stratum under these beds, whether on the coast or inland, was a soft clay, more or less greasy, and of different colours from bluish to grey or brownish. This stratum was frequently of great depth; and, if the entombed trees and other hard-wooded plants grew where they were now found, no fitter soil could be imagined for the nutrition of oaks and other forest trees, from its containing all the requisite inorganic elements, of alumina, silex, and lime, for the growth of the largest timber. The animal remains found in the submerged forests were not very plentiful. They consisted chiefly of the bones of terrestrial *mammalia*; viz. of the gigantic elk, the red deer, fallow deer, *bos urus* or *auroch, bos bovis* or common ox, tusks of the horse; and also of the hippopotamus, bear, and canine species; and the heads and tusks of a species of boar. As for those animal remains which had been found at Kirkdale and Plymouth, and which were now ascertained to have belonged to the elephant, the rhinoceros, the hyæna, the hippopotamus and tiger, he considered it highly probable that those animals belonged to the geological era of those forests, or that they were extinct very shortly before that period. From considering the present position of the submarine beds and the coverings of sand, drifted pebbles, and silty clay, with which they are covered, he was of opinion that great changes in the levels of land and sea must have taken place, to account for the existing phenomena. On this point nearly all geologists were agreed: what they differed about chiefly was, as to whether those changes had been owing to the subsidence and elevation of the land, or to an influx and retrogression of the sea. Having entered at some length into a consideration of this interesting branch of the subject, he summed up by stating, that the conclusions to which he had arrived were: 1st, "That there existed around the once more extensive shores of the island of Great Britain, and in many parts in the interior of the country, forests of hardwood, some of great dimensions, and an under-vegetation of shrubs and grasses, similar to the flora of such species as are now growing on the present surface; but which are now either entombed by drifted gravel or sedimentary sand, silt or clay, and are, more or less, washed over or covered up by the surrounding tides and deep sea; or else they are buried over by mosses and peat bogs, the growth of subsequent ages. 2nd, That, in addition to the *fauna* of the present day, the animals which inhabited these primeval forests were the gigantic elk, the *bos urus,* or auroch, now only found in the forests of the Crimea, the bear and wolf; if not the elephant, tiger, rhinoceros, and hyæna. 3d, That the period in which those primeval forests once lived and grew in *pleno aere* was *post pliocene,* and immediately anterior to the last notable geological change that has generally affected the surface of our island. 4th, That a gradually increasing higher level of the sea towards the summits of our highest hills was the first process of the submergence of these forest beds, littoral and landward; and their subsequent entombment in the lower levels was owing to the greater or less delay in the subsidence of the water level—producing drift from quick secession from the higher grounds, and allowing of sedimentary deposits on the lower, from intermittent and slow subsidencies, till nearly the present levels have been obtained. 5th, That the whole phenomena do not clearly lead to the alternate conclusion, whether this first change of level was owing to subsidence of the land, or to elevation of the water; but it is more probable it was effected by a rise in the surrounding sea, from the uniformly horizontal marks of the several sea levels round our coasts. 6th, It is, moreover, inferred, from the prostrated state of the trees in these forest beds, lying nearly in one direction, in the same area of submergence, that the secession of the waters was accompanied, in some period of its duration, with a current of some force, and that from the points between N.W. and N. E. 7th, It is not yet satisfactorily shown upon what geological operations, either normal in kind, or cataclysmal in character, the subsidence of the land or elevation of the water, at this epoch, depended."

Mr. Binney stated, that the peat bogs of Lincolnshire, Nottinghamshire, and Yorkshire, which he had inspected, led him to believe that they were of comparatively speaking modern origin, and certainly formed posterior to the deposits of till and regular gravel. He was in possession of Roman coins found under a bed of peat, at Misterton, near Gainsborough; and stone celts had been discovered embedded in stems of trees dug out of mosses, in the same neighbourhood. In 1746, the body of a female, clothed in skins, and in perfect preservation, was found six feet deep at the bottom of a peat bog, in the isle of Axholme. He had never, in the districts before named, seen a bed of peat covered with till or regular gravel, although he had often, in the valley of the Trent, found from fifteen to twenty feet of river silt or *warp* upon peat; and at Hornsea, on the Yorkshire coast, he had observed beds of common sea sand and shingle, in the same position; but in both these cases the till occurred *under*. In the level of Hatfield Chase, and the low lands adjoining the

Trent and Ouse, are found great quantities of large timber trees, consisting of oak, yew, and pine. None of these trees could possibly have grown on the low and swampy positions in which they are now discovered; and they evidently seem to prove, that the land on which they now lie, and no doubt formerly grew, has undergone a subsidence; or else that the beds of the rivers beforenamed have been raised.—Mr. Binney considered, that the thin beds of peat found at Clammer Clough and Cheetham, both of which are covered with deposits of clay, are of a different age and character to those he had above alluded to.—The Chairman stated, that he had been informed, by parties resident near Chat Moss, that a place on the bog, called the Ringing-holes, had been proved by sounding to be upwards of 100 yards in depth.

DUDLEY AND MIDLAND COUNTIES GEOLOGICAL SOCIETY—WOLVERHAMPTON BRANCH.

At the First Annual General Meeting, held on January 23, 1843, Rev. Mr. Lister, V. P., in the Chair. The following Report was submitted.

In presenting to the Members the first Annual Report of the Wolverhampton Branch of the Dudley and Midland Geological Society, your Committee have a most gratifying task, inasmuch as the present condition and prospects of the Society far exceed their most sanguine expectations, and afford evidence of the increasing interest taken in the science of Geology. They feel assured that the taste which has been created among the members will be increased by a more familiar intercourse with the mighty monuments of by-gone ages, exhibited in the varied strata of the globe; and which are, in many respects, so beautifully developed in this immediate district. The establishment of your Society has removed a stigma which hung over the denizens of your ancient Town, and offers the fullest contradiction to the oft repeated assertion that Science and Literary Associations have here no attractions. The numerous audiences which have attended the Meetings of your Society tend also to show that even one science is sufficient of itself to command attention; this is a point of no slight importance; the concentrated efforts of your members, directed to one focus, being not only more likely to extend an acquaintance with the principles of Geology as at present known, but also to lead to new discoveries.

In reviewing the proceedings of the last year, it must be borne in mind that few members of your Society possessed more than a superficial view of Geology. Your Committee deemed it, therefore, necessary to recommend a course of papers to be read, which would furnish the simple and undoubted details of the science, rather than to rush at once into more profound speculations; with this view the papers have been (with one or two exceptions) introductory ones. Your Committee have to tender their warmest thanks to those members who so promptly accepted invitations to deliver the results of their studies and observations; and they have great pleasure in stating that arrangements have been made for a regular succession of papers for the year 1843. The paper for February will be from the pen of the lady who so obligingly favoured the Society with a Dissertation on the Fossil Flora, in December, 1842.

Your Committee considering that a selection of the characteristic fossils of the several strata would materially assist the Lecturers, determined on purchasing a small Cabinet;

and an opportunity offering to possess a few rare specimens at a small expense, they availed themselves of it, and thus formed the nucleus of the present collection.

Having reported upon the past proceedings of your Society, your Committee trust they may be permitted to allude briefly to a few points which may conduce to the permanent welfare of the Institution.

In the first place it must be remembered that, being merely a Branch of the Dudley Society, your efforts should tend principally to elevate the importance of the Parent body. Some individuals have expressed an opinion that the members in Wolverhampton should become an "independent formation." The policy of this would be doubtful, even if you possessed an abundance of working bees in your own hive:—without them, it is far better to go hand in hand with the Parent in mutual interchange of information and good offices.

The fame of the Dudley and Midland Geological Society has gone forth through the length and breadth of the land, and there is not a collection of importance in any part of the globe which does not boast of its Dudley fossils. The "bright beaming light" which hangs over the Parent Society must necessarily shed its influence on her satellite, and it will be well if the labours of your members are in emulation of the indefatigable industry and great scientific acquirements of the originators and leading members of the Parent Society resident in Dudley.

It may be asked, how is your assistance to be given? Your Committee submit that any investigations originated by the Parent Society, especially in the details of the Mining Districts, may be materially aided by several of your practical members; an instance may be given in the report on the Igneous Rocks, read at the first quarterly meeting in Dudley, wherein a valuable mass of original information connected with your immediate district was afforded by Mr. W. Sparrow, a gentleman, whom your Committee could wish would more often be induced to take part in your discussions, and give the Society the benefit of his practical experience and observations.

A very important investigation connected with the South Staffordshire coal field now engages the attention of the Dudley Society, viz.: the faults or dislocations in the various strata. These are sources of much perplexity and annoyance to the miner; by whom their origin and bearing are very imperfectly understood. It is the intention of the Sub-Committee appointed to examine the subject, to give attention to all the known faults,—to examine their causes and effects, both present and ulterior, to record their position on maps of the district, and to obtain all available data towards forming definite views as to the extension of the coal field beyond the hitherto supposed boundary. The Sub-Committee consists of several intelligent ironmasters in the neighbourhood of Dudley, and includes several active Members of your branch, who will doubtless give every assistance they may possess in furtherance of the cause.

An interesting subject which should engage your attention, and one which is peculiarly within your province, will be found in the boulders of this district. Immense blocks of rounded sienite, porphyry, trap-rock, and (rarely) true granite, are constantly met with in the alluvial soils, and not in those alone, but at very considerable depths below the surface. The otherwise useful labours of M'Adam have caused a sad diminution in the number of these *stumbling blocks* to the Geologist, by putting it into the heads of the surveyors of roads to break up the venerable relics for road materials; and what is the consequence? They are now only to be found in rural and retired retreats, and are rapidly ceasing to be. Yet these blocks, if they were gifted with speech, would tell of events long past,—perhaps of the action of mighty streams which once swept over them, or it may be of enormous icebergs, which conveyed them from remote regions to—puzzle posterity. Before all traces of these boulders are lost for ever, it would be well that their position should be accurately noted down,* their probable weight, the degrees in which they are rounded by attrition or other causes, and the nature of the beds in which they are associated:—these observations should be attached to a fair specimen of each mass, and deposited in your Museum. By degrees a sufficient body of information may be obtained to show the path in which they have steered, and eventually their original localities. Connected with this subject your Committee would call your attention to the deposits of lias fossils found in the new red sandstone of Compton and Wightwick, which have apparently been there deposited by a tidal stream;—how great is now the change!

Formations and cuttings in the new red sandstone, and sections of the various sinkings for water in the town of Wolverhampton, would be useful documents in the archives of your Society: these are easy of access to some individuals, who probably are not aware of their ulterior value.

Another subject which might profitably engage your attention, is the limestone formation more immediately connected with the Wolverhampton coal field. The upper or Ludlow rocks of the series possess the property of setting under water, and are well developed at Sedgley Beacon, and on the west side of the road leading from Wolverhampton to Sedgley. These rocks have been but little examined;—the fossils are not so numerous as those belonging to the Wenlock and Dudley rocks, but perfect specimens are far more rare. This deposit merely edges the coal field in one direction, but apparently does not extend beneath it. Nearly adjoining Sedgley Beacon is a siliceous deposit connected with the Gornal sandstone, and probably the equivalent for the millstone grit, which is not known in any other part of the district.

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* These boulders are noticed in Murchison's map, but merely as occurring in the neighbourhood of Trysull and Pattingham.

The Wenlock and Dudley rocks are well developed at Hurst Hill, crossing the road leading from Sedgley to Bilston, and barely three miles from Wolverhampton. The fossils are here abundant, very beautiful, and easy of access in the upper measures. It has been stated to your Committee that the dislocations in the lower measures are of a singular and complicated character, and highly worthy of examination.

Taking a nearly direct line from Hurst Hill to Walsall, your Committee find that the limestone, or rather, perhaps, limestone shale, has been sunk into at Monmore Green, near Wolverhampton; the particulars of this sinking would form a valuable addition to your Society's papers. The next point of sinking is in the Bentley Estate, belonging to the Trustees of the Countess of Lichfield. By the kindness of the agent, Mr. George, your Committee have obtained a section of the strata passed through, and many of the fossils, which are perfectly identical with the Dudley specimens.

The limestone at Bentley, so far as at present examined, consists of two beds: the first being four yards thick, and about 125 yards from the surface; it is admirably adapted for the iron furnaces as a flux. Below this are 39½ yards of shale, with limestone nodules, and then the main bed of limestone eleven yards thick. In the neighbourhood of Walsall, these two beds rise to the surface, and being less frequented than the rocks south of Wolverhampton, offer rich treasures to the collector. About three miles from Walsall, on the road to

Sutton Coldfield, some of the lower measures of the Wenlock and Dudley limestone rocks rise to the surface, and are in great repute for hydraulic purposes; among the fossils found therein was the Bumastus Barriensis, or Barr Trilobite, now in the cabinet of Miss Jukes, of Birmingham. A few shells from these measures were long considered peculiar thereto; one among them, Leptœna Transversalis, absolutely abounds; it has, however, been lately also found at the Wren's Nest.

Lest your Committee should tire you with such long flights, they would beg to conduct you nearer home, and recommend to your notice the strata of your own immediate locality. The fossils are not considered to possess great variety, but many of them are of a highly interesting character. Some varieties of the Stigmariæ and Lepidodendron have, at the request of Mr. Stokes of London, (a gentleman well-known for his researches among the fossil woods) been forwarded by your curator to him, and the result of his examinations will probably, ere long, occupy the attention of the London Geological Society. From the numerous fragments of Saurians, there is little doubt, diligent investigation will enrich your cabinet with perfect specimens. There is no reason why your Branch may not discover and possess a specimen equal to the Megalicthys Hibberti, which adorns the Museum in Dudley, and which, perhaps, is the finest in the world. In examining the position of the strata, it may be supposed little can be done without descending the pits; it is true, these are the real scenes of action; but it requires a long acquaintance with the murky caverns of the mineral world, before the tyro becomes accustomed to the varied appearances of coal, shale, basalt, or ironstone. There are, however, a few open works in the district, which may be studied with interest, especially a large one, belonging to Mr. Philip Williams, near Wednesfield Heath; this is worked up to the great Wolverhampton

Fault; it exhibits the upper measures in well defined beds, and is occasionally varied by an outbreak of trap of peculiar character. In this open work have been found fossil trees, upwards of twenty feet in length, and shells apparently allied to the freshwater mussel in myriads, evidencing the inland origin of the strata. A large open work belonging to the trustees of the late Earl of Dudley, near the Wren's Nest, will also amply repay a visit. It has been long supposed that the Basaltic Rocks were unknown on the western side of the Wolverhampton Fault: some of your members, have, however, discovered a bed of a remarkably compact nature, which protrudes through the new red sandstone, and comes to the surface about 300 yards north of Essington Brick Yard, and about a quarter of a mile west of the fault. The new red sandstone is well developed beneath the excavated clay, and leaves no doubt, which otherwise might arise, with regard to position. The nearest known point in which the Basalt occurs, is in a pit, sunk by the late Mr. Underhill, at Pool Hayes, about 1½ mile south of Essington Brick Yard, and within the known range of the coal field; the Basalt at Pool Hayes is of great thickness—(Mr. Underhills's borings in it being 54 yards). The character of the rock is not so compact as that at Essington, owing to a difference in the cooling of the mass, and is remarkable as containing fine chrystals of carbonate of lime, Mesotype, and Prehnite. The Pool Hayes basalt is undoubtedly connected with the continuous beds of Bentley, Willenhall, Wolverhampton, and Bilston; and your Committee would suggest the importance of ascertaining the connexion, if any, between the basalt at Pool Hayes and Essington; and also of making diligent inquiries as to the probable extension of the rock in other localities, westwardly of the great fault.

MISCELLANEA.

*Drainage considered as a Science dependant on Geology, with proofs, deduced from the structure of England.**

There are two very important considerations why drainage should be made a study, independent of the more ostensible reasons connected with the question. The first of these, is, the more abundant produce on the application of the labour of the agriculturalist; the second, the preservation of those natural powers, which, when properly applied, may be made subservient to the purposes of man.

There is a third question which affects both these, and proves that the labours of the man of science may be directed to this subject, with every prospect of ample repayment; and this is, the formation of a system, which, by being regulated by natural circumstances, overcomes the greatest barrier, viz.—expense, and which would enable us to apply the system upon a general and broad scale, whereby, not individuals only, but the community at large, agricultural and mechanical, would derive the benefits of reduced prices, abundance, and health. These three desiderata would be an all-sufficient recommendation of the question to the politician; and as they lay more within the province of the surveyor to exemplify and prove, we will leave it for them to argue between themselves, devoting our attention to the great principles upon which the science of drainage depends.

By drainage, we would not have it understood that we meant merely the desiccation of the soil; it is not everywhere that such a process is requisite: but, if by collecting the superabundant water in some places and discharging them in proper quantities over other districts where crops fail from want of subterranean moisture, we so modify the state of things that both are rendered more productive; we rank the two—the proximate and the ultimate effects—in one common term.

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* Being a paper read at a late meeting of the Scientific Society of London, by Charles Moxon, Esq.

To effect this object, we have then to collect and discharge the surface waters of the country; we have need of the formation of drains, the efficiency of which depends upon their situation and fall; the discharge of the waters therein collecting, being a question to be determined only by local causes. It is simple enough to get rid of water when once the drains are formed and the water itself collected, the difficulty resting on the proper construction of those drains. When drainage has to be constructed upon an extensive scale, we find also that the ordinary artificial means of leading or conveying the waters collected are inapplicable, and we therefore have to search for some method whereby we may ensure our object being accomplished. It is to this that I propose calling attention in this short essay, hoping to prove the truth of what I have already advanced upon the strength of my own reflection, and by degrees lead to the adoption of a more generally useful plan than that by which each landowner performs his task for himself, without one consideration for the help which he might give to others, and without considering that by thus performing one neighbourly act, he receives the advantage of a diminution of expenditure in the drainage of his own ground. The question is, therefore, upon what general principle can drainage be conducted, so that man may be facilitated in his work by the laws of nature, thus enabling him to perform his task with less labour and expense to himself, whilst the national advantage would likewise be consulted.

Every one by this time is acquainted with the nature of artesian springs, their origin and explanation. I would therefore introduce them as an example of the benefit which might be derived by the course which I am about to consider. They are, from their simple construction, among the best exemplifications of the triumph of modern science, which, although of less seeming importance than the works of ages now long past, which for magnitude or contrivance are yet without parallel, are the greater proofs of man's superior mind and abilities. Nor need we trace the rise of this power from so remote a period—geology was yet in its infancy at the close of *last* century, and the treasured stores were yet unsealed. How rapid then must we regard the achievement of such important objects, if they are the offspring of man's observation of nature during the short period which has since elapsed. By boring on given principles we can now obtain a supply of water, which in former times would have of necessity entailed expensive operations, and this without any subsequent application of labour.

Having thus adduced one proof in support of our argument, we will proceed to the question at once, and will endeavour to demonstrate in what manner a system of drainage might be devised which should answer all the purposes of agriculture in its adaptation and economy. We will take a review of the geological construction of this country subsequently, in order to show the feasibility of the plan, and the general application of the rule.

There are two circumstances to be considered in drainage, the one absolutely dependent upon the other.

I. The rise and fall of the ground.

II. The collection and distribution of surface waters.

To these we might add a third; only for the sake of simplifying the subject we can dismiss it with a few remarks—this is the *subterranean* water level; but our attention in the first instance at all events is directed to the surface drainings, and therefore, was it for this reason only, the question of subterranean waters would be set aside for the time; the more important reason, however, is this, that as the subterranean water level is the result of the absorption of surface moisture, whether derived from rain or other meteoric changes, so it is affected by the question of surface drainage, and is therefore a secondary subject.

The first principle of artificial drainage is that, which is adduced from a consideration of the process adopted in nature, by which the rains and surface waters find one common level on the surface of the globe;—this is the question of rise and fall in the ground. Let us therefore consider a case in point.—Suppose rain to fall on the summit of an isolated mountain range, the construction of which is uniform, the fall of the ground, from the summit to the general level, being the same on all its declivities, the rain would naturally find its level by all sides of the range; and the neighbouring strata would all partake of its influence in nearly the same degree; again, suppose this range of hills to be composed of an outward barrier of hills, between which and the summit, a valley or even a slight depression of ground existed; the case would now become changed—the surface waters, which in the former case had found the level over all the sides of the range, would now be collected in the intermediate valley, and conveyed by these natural channels to the first place of exit, if there were such; or if not would form an elevated lake or pool. These two examples, then, show by what means the surface waters are collected by nature, and hence we are led to adopt a similar course in order to collect the same waters where it is yet needed, and thus to modify the irrigation.

It is clear, then, that the natural physical features of a district must be observed, if we wish to pursue our work of drainage effectually.

Having thus, by means of the natural irregularities of surface, been shown the means of collecting the surface waters of a country, and profiting by the kindly suggestions of nature in guiding us in our subsequent modifications, it remains for us yet briefly to examine the processes by which the distribution is effected. So long as the valleys (by means of which the surface waters are carried off) are of such a nature that they resist the action of water, so long is the watercourse complete; but as this is not always the case, and their course runs over porous soils, an absorption of the water takes place, or in other words, we have a natural distribution. Supposing, for instance, that the course was in a clay stratum, non-absorbent in its properties, we should find the natural drainage complete, so long as the waters were carried in the bed of this formation; but immediately that a change took place in this respect, and a porous stratum occupied the position where a non-porous rock had heretofore been, the waters thus collected would fall from the surface of the non-porous stratum to the subterranean water level in the porous rock, at whatever depth that might be. Examples of this we find are frequent, and their detrimental effects may be observed in very remote, as well as proximate localities to the point of absorption; of these we shall elsewhere give proofs.

This preliminary inquiry introduces two other points, which although seemingly self-apparent, we think it better not to pass over without remark;—that is to say, the nature of the porous and non-porous rocks:—for upon this, in conjunction with our previous statements, we shall found the greater portion of our suppositions; and they may be said to suggest the feasibility of a general system of drainage, whereby the very soils which from their qualities had previously been unproductive, would be rendered fertile, by the simple extension of the natural process of irrigation or drainage; for, we should remark, ere we quite forget the second part of our argument, that these two processes are dependent one upon the other.

The following statement shows the nature of the various strata, &c., in their order of superposition:—

⁂ Gravel and sand-beds, overlying many of the formations, uniformly porous.

Porous.	Non-Porous.
Crag	
Freshwater beds	
	London clay—Plastic clay
Sands of the Plastic clay	
Chalk (all the beds)	
Greensand (ditto)	
	Weald clay, &c.
Portland oolite	
Sand	
	Kimmeridge clay
Upper calcareous grit	
Coralline oolite	
Lower calcareous grit	
	Oxford clay
	Kelloway's rock
	Clay
Combrash	
Sand	
Forest marble	
	Clay
Bath oolite	
	Fullers' earth (variable)

Porous.	Non-Porous.
Inferior oolite	
Sand	
	Upper lias shale
Marlstone	
	Middle lias shale
Lias limestone	
	Lower lias shale
	Variegated marls
Variegated sandstones & conglomerate Knottingley limestone	
	Gypseous marl
Magnesian limestone	
	Marl slate
Rothetodteliegende	

From the Carboniferous system downwards in the series, generally porous; the alternations are, firstly, coal and sandstone; then, sandstone and limestone—limestone and slates—slates and granite, or primary rocks.

We shall, in a future portion of our essay, make use of this comparative table, and we will not therefore test its adaptation in nature to the process of drainage, until the fact speaks for itself: by this means we shall avoid recapitulation and unnecessary length.

The inquiry resolves itself, by what we have shown in the preceding remarks, into a very simple comparison—

The rise and fall of ground	The elevation of primitive and transition rocks
The collection and distribution of surface waters	The comparison of porous and non-porous rocks in their reciprocal relations.

Having arrived at this result, upon which we propose to found our argument, we will at once proceed to the subject.*

The principal geological divisions of England indicate very clearly a distinct series of altitudes, which, as we have before remarked, is the fundamental principle of the system. We have a tertiary series on the eastern coast of England, gradually rising towards the commencement of the secondary strata, and so on in the ascending scale, until the transition rocks complete the summit, and there is the natural fall again towards the sea boundary: this is the latitudinal section. The longitudinal sections vary much more in their character. A line drawn due north and south through the eastern counties would present but little variation of altitude, the strata being tertiary in their character, and only slightly undulating. Further to the west, the line would pass through a slightly elevated range of the more recent secondary rocks, and by continuing the series of lines, we should find that it had a progressive series of increased altitudes, until that which intersected the elevated district of Cumberland, Lancashire, Cheshire, Gloucestershire, Somersetshire, &c.

Now, for a moment survey the escarpments of the coast, which present themselves at those points to the west of this line. We have a bold outlier along the coasts of Cumberland, Westmoreland, and Lancashire, and again in Devonshire —on account of the character which it would have presented, had not other causes disturbed the sequence of the depositions, but of which ample evidence is afforded in the increased altitudes of the projections of Cornwall and Wales.

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* An interesting article on drainage and irrigation will be found in the *Westminster Review* for December, 1842, not so much suggestive of the mode in which this important agricultural economy might be carried out, but explanatory of the advantages which drainage would produce, and irrigation insure. Our readers would do well to compare the subjects of the articles published in this Work and the *Westminster Review*—the works mentioned at the heading of the latter—and a pamphlet on drainage, entitled "a Letter to Philip Pusey," by J. Bailey Denton, Esq., recently published by Ridgways.

Thus you have a progressive increase of altitude as you proceed from east to west.

This at once establishes the principle that drainage could easily take place from the more lofty parts of England towards the marine level; and this geological definition of the comparative altitudes, and the rule for drainage thus afforded, is proved by the course of the rivers being precisely analogous· They rise in the regions which—geologically speaking and *à priori* in reality—are the highest and fall mainly to the eastward, whilst a few find outlets in those picturesque watercourses for which Wales, Cornwall, and the north-western counties are distinguished.

Let us now look at the courses of these rivers. The greater number among them—and these include the principal rivers in this country—have their courses over secondary rocks, generally speaking of a non-porous character: this applies in a more especial degree to the navigable rivers, which are navigable only so far as their course extends over non-porous ground. Thus the Thames, the Ouse, the Humber, &c., run over ground more or less of a clayey or non-absorbent quality, and the point at which the oolitic or greensand strata is reached, is simultaneously the point at which each is liable to desiccation in the warmer months, and hence become unnavigable.

This affords another illustration—viz.—that nature provides for drainage and irrigation in some measure without the assistance of art. But, whereas in the earlier days of civilisation, the inhabitants of a country locate themselves for this very purpose on the banks of streams, so as population increases, do they gradually find their way inland; and hence the necessity of providing, artificially, for what nature had originally designed no support.

But we have established the rule—*that nature has laws of* *her own*—artificial means must therefore follow upon the principles of the laws of nature.

The origin of all moisture, whether atmospheric or subterranean, is more particularly plentiful in the higher levels, and hence the principle of drainage commences from the higher parts of a country. The engineer then has simply to carry the water collected in these parts along such strata as are impervious to moisture, and which additional moisture is not required until it reaches the porous soils, which, independent of requiring more complete saturation, are likewise liable to greater exhalation; and on these he would distribute, by proper water-channels, such a quantity as he would consider sufficient for the purpose of promoting agricultural produce, at the same time providing for the due conveyance of a proportionate quantity to the absorbent levels situated lower in the descending scale. The advantages of this system are evident in this country, and their application very simple, inasmuch as the strata run, with but few exceptions, in directions nearly parallel to each other, and hence admit of very simple principles for distribution of the surplus waters. This will give a distinct idea of the plan upon which the engineer may forward many of his plans for the important object of drainage and irrigation.

We shall probably revert to the subject in a future number.

On the Mineral called "Ottrelite." by M. M. Descloizeaux *and* Damour.—*Translated from the French.*

The Ottrelite has been known for some years in many mineralogical collections, but as there is yet no published description, it is classed amongst the list of "Minerals of which the nature and properties are unknown." By some it has been ranked with Diallage. It is named from the small village of Ottrez (near Stavelot), on the confines of Luxembourg and Liege, where it was first found. The great abundance of this mineral in all the slaty rocks near Ottrez or some parts of that neighbourhood, and the very slight resemblance between its internal characters and those of any other mineral with which we are acquainted, are sufficient reasons for establishing its distinction.

It is found in small flat discs—one to two millimetres in diameter, and rarely (if any) more than half a millimetre in thickness. These discs are always so firmly set in the argillaceous slaty matrix in which they are found, that we have never yet been enabled to detach any sufficiently perfect to enable us to determine the exact form—they evidently belong to an hexagonal prism or very angulated rhomboid. The colour is greyish black with a shade of green, this is visible in the small translucent fragments; the dust, when pounded, is of a pale green.

The only clearness observable is in the horizontal direction parallel to the base of the small discs—the fracture is slightly conchoidal, and in other respects the fracture is unequal.

It scratches glass slightly.

The specific gravity is 4.40.

This mineral disengages a small quantity of water when tested in a closed tube. On exposure to heat the angular points disappear, and a black globule is formed. With borax, it dissolves slowly; with carbonate of soda or platina-foil, the presence of manganese is prominently visible.

The powder is soluble in heated sulphuric acid only.

The following are two analyses made by Mr. Damour.

			Oxygen.		Proportion.
1st.	Silica . .	0·4352	0·2260		4
	Alumina .	0·2389	0·1115		2
	Ferric Acid	0·1681	0·0382	0·0562	1
	Manganic Acid	0·0803	0·0180		
	Water .	0·0563	0·0500		1
		0·9788			

			Oxygen.		Proportion.
2nd.	Silica	0·4334	0·2251		4
	Alumina	0·2463	0·1150		2
	Ferric Acid	0·1672	0·0380	0·0563	1
	Manganic Acid	0·0818	0·0183		
	Water	0·0566	0·0503		1
		0·9853			

The small discs of Ottrelite are disseminated profusely through all the transition strata of the above mentioned locality, generally of the grey colour, but sometimes of a fine rose, in fine flakes equally distributed in layers between the laminations, and at other times completely filling the rock, so as to give the matrix the appearance of the mineral itself.

New Acid of Sulphur.—At the sitting of the Academy of Sciences, on the 13th ultimo, M. Pelouse read a report of the discovery of a new acid of sulphur, recently made by Messrs. Fordos and Gelis. The experiments performed by these gentlemen have been repeated by the commission of the academy appointed to report upon the discovery, and the same results have been obtained, leaving no doubt, from the tests applied to them, of the existence of this acid in the compound indicated by them. The series of the oxygenated combinations of sulphur, to which sulphypo-sulphuric acid was added by M. Langlois, about two years ago, has received the addition of a new acid; thus, consequently, making the number of its compounds six.

Interesting Fossil.—Mr. Bensted has discovered a unique specimen in the Iguanodon Quarry. The fossil is of the order Testudinata, and is apparently a marine turtle. It has a circumference of nearly three feet, and some of the marginal and other plates may be seen in their proper position, but some of the ribs are displaced. Two or three vertebræ, with fragments of the carapace, or shield are very distinct. In clearing the stone Mr. B. expects to find more bones than are now visible.

Relative Levels of the Caspian and Azoff Seas.—At the Paris Academy of Sciences, a communication was received from M. Hommaire Dehel, on the difference of the level between the Caspian Sea and the Sea of Azoff. Several scientific men have been charged by the Russian Government to ascertain the level between these two seas; but the results have differed so much that a verification was necessary, and this was undertaken by M. Hommaire Dehel, in 1838; but it was not until September, 1839, that he could establish his points of survey. M. Hommaire Dehel, now reports that 18·30 metres is the difference of level between both seas. It results, from the observations made by M. Hommaire Dehel on the shores of the three seas of Southern Russia, at the mouths of the different rivers and streams in the steppes of Astrican, and at the Sea of Azoff, that the Caspian Sea had formerly a much higher level, and that it was united with the Black Sea, at a period anterior to any existing historical records. Already this idea as to the junction of the two seas has been maintained, but it was said that the Black Sea had become lower by piercing its way through the Bosphorus, and shedding its waters into the Sea of Marmora. The sinking of the Caspian Sea has been accounted for by the lowering of the basin, but M. Hommaire Dehel gives an explanation of this, which he conceives more natural, by observing that the Caspian Sea has very few tributaries, and that a diminution in the waters of the Oural and the Volga has been a sufficient cause for the lowering of the level of this sea.

Earthquake in the West Indies.—The very violent earthquake which was recorded to have occurred early in the present year, and was attended with such disastrous results, was, according to subsequent authorities, felt more or less violently throughout the whole volcanic range in that district. It is recorded to have been also felt in Spain and Hindostan.

REVIEWS.

Report on the Geology of the County of Londonderry, and of Parts of Tyrone and Fermanagh; examined and described by Authority of the Master-General of the Ordnance. By J. E. Portlock, Esq., F.R.S. Longman and Co., 8vo.

From Geological surveys we expect great results in every instance, not only in addition to our knowledge of the surface geology of the districts to which they relate, but the more minute particulars, calculated to advance the science—not merely the profession—although, as we have endeavoured to show on more than one occasion already, the value of this science is tested by its practical utility. All that we contend for is this—that an authorized geological survey should exhibit not merely the superficial extent of strata, but should be accompanied by the facts, calculated to add to the data of geological science, else a chart would be preferable to a book. In the work before us, we had certainly expected to find these two combined with more interest, and the occurrences explained with better reasoning than is the case. In fact this "government survey" appears to us to add little more to our knowledge of Irish Geology than we already possess.

Figures and Descriptions of the Palæozoic Fossils of Cornwall, Devon, and West Somerset, observed in the course of the Ordnance Geological survey of that district. By J· Phillips, F.G.S. Longman, and Co., 8vo.

What we have said in the preceding Review with reference to the objects of general surveys, is applicable in the present instance in so far as the work to which we now call attention, is a portion of a great undertaking of a similar nature, the details of which have been recorded by separate authors. To those who have interested themselves in the recent contest concerning geological types of the older strata, this work affords abundant matter of interest, and its individual character is fully explained by the circumstance above described.

Description of the Skeleton of an Extinct Gigantic Sloth (Mylodon Robustus), with observations on the Osteology, natural Affinities, and Habits of the Megatherioid Quadrupeds in general. By Richard Owen, F. R. S. Van Voorst, 4to.

This work is published by order of the Council of the Royal College of Surgeons, and independent of the interest which belongs to it as explanative of another extinct animal, we cannot refrain from observing that we think the generalizations on Megatherioid quadrupeds by far the most interesting portion; it shows, moreover, how successfully the comparative anatomist may reason when the number of distinct observations is sufficient for his purpose, and that the dull routine of recording peculiarities of one fossil representative of an extinct family or genus, is amply repaid by the remarkable discoveries of natural affinities which are demonstrated by subsequent comparisons.

MEMOIRS.

On the Geology of Russia and the Ural Mountains.

By R. I. Murchison, *Esq.* F.G.S.

Having occupied much attention during the past season with memoirs on the Geological Structure of so large a portion of the earth as the Russian empire, I must make a few allusions to a subject which has to a great extent engrossed my thoughts and those of my coadjutors, M. E. de Verneuil and Count A. Keyserling. Employed as we are in preparing a work explanatory of our views, in which we hope to do justice to all previous inquirers*, and to the Imperial Administration of Mines which supported us, I will not on this occasion venture to occupy more time than will be sufficient to touch upon some of the most striking geological features of that empire, which either sustain or enlarge our views of classification and comparison.

Silurian Rocks.—The Silurian, Devonian and Carboniferous deposits of Russia, are each characterized by distinct organic remains; and these rock systems are very clearly separated from each other over enormous spaces. Occupying (including the Baltic islands) a tract as large as the principality of Wales, the Silurian rocks, like those of Norway and Sweden, are unequivocally the oldest fossiliferous strata, since they are seen to repose upon the primary crystalline masses of Finland and Lapland. Little elevated above the Baltic Sea and the rivers of the northern watershed of Russia, these Silurian rocks constitute low plateaus only of limestone, clay and sandstone, often incoherent, and on the whole of very small thickness; thus exhibiting the most obvious contrast to their mountainous and frequently subcrystalline equivalents in Western Europe and the British Isles. In their small vertical dimensions they present to us, indeed, a very instructive lesson, for in passing from Norway, Sweden and Gothland into Russia, the distinguishing strata thin out, and losing their divisionary lithological characters, part also with many of their characterteristic shells. "When followed from one region to another, deposits of all ages exhibit like constructions and expansions, dependant on the forms of the ancient bays, the nature of the springs and currents, and the depth of the seas in which they were accumulated†."

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* During its preparation, our general map of the Russian Empire has been much improved in its north-eastern extremity, the country beyond Archangle which we did not visit, in consequence of the observations of the distinguished botanist Mr. Ruprecht.

Devonian Rocks.—If the horizontal range of the Silurian rocks of Russia be considered large as respects our terms of comparison, what will my associates say to the expanse over which the Devonian or next ascending group is spread, when I tell them it is much larger than the whole of the British Isles? Reposing upon the low Silurian plateaus, this widely ranging deposit rises to heights of from 500 to 900 feet above the sea; and it is very remarkable by being charged in many localities with ichthyolites, several species of which, hitherto considered peculiar to the Scottish Old Red Sandstone, are found associated with Mollusks, perfectly similar as a group, and often specifically the same, as those of the limestones of South Devon, the Boulonnais and the Eifel. The discovery of the intermixture of Scottish Old Red Sandstone fishes and true Devonian shells in the same strata, was, you may believe, one of the most gratifying results of the recent explorations in Russia, as being confirmatory of the views of Professor Sedgwick, Mr. Lonsdale and myself respecting the divisions and equivalents of that member of the Palæozoic Rocks. In some parts of Russia, the Devonian rocks are red sandstones and marls; but in an extensive central tract, where they rise into a dome which separates the northern from the southern basin of the empire, they are composed of yellow sandy marls and limestones, which lithologically might be mistaken for the magnesian limestone beds of our northern countries: so inapplicable are mineralogical terms as marks of geological epochs.

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† Geological Researches in Russia (in the press) by Roderick Impey Murchison, E. de Verneuil, and Count A. von Keyserling, assisted by Lieut. Koksharof, p. 40.

In the vastness of their undisturbed and nearly horizontal extent, these strata afford us most instructive proofs of the intimate connection between the stony condition of the rocks and the imbedded fossils; for, when the calcareous matter is present, various mollusks are associated with some fishes, whilst in those tracts where the limestones disappear and the beds have the characters of the Old Red Sandstone of Scotland, fishes only can be detected; thus presenting a remarkable analogy between the distribution of this very ancient fauna and that of existing nature; the present great receptacles of fishes being deep sandy bottoms, whilst shelly creatures congregate towards the shores where calcareous springs attract them. I have elsewhere alluded to the fishes of this deposit when speaking of the researches of Professor Agassiz.

Carboniferous Rocks.—The Carboniferous deposits, which succeed, cover an area as broad as that of the Devonian or Old Red rocks; and they are throughout clearly distinguished by a decidedly distinct type of animal life, presenting in some families an extraordinary number of species absolutely undistinguished from those of our own country, published in the works of Sowerby and Phillips. This system is eminently calcareous, and exhibits a vast marine succession, in which the fossils of the Mountain Limestone prevail, whilst in no part of the empire is there a trace of the overlying deposits, with which we are familiar under the term of "coal-measures." Coal, however, does occur at intervals, both underlying the carboniferious limestone, as in Berwickshire, and alternating with its central and upper members, as in Northumberland, and the carboniferous valleys of our lake country.

Of the latter, the extensive tracts in the south of Russia, occupying from 10,000 to 11,000 square miles, and usually known as the country of the Donetz, offer a very striking illustration; containing in one district as many as seven good seams of coal subordinate to sandstone, shales and limestone, very analogous to those rocks which abound in the western dales of Yorkshire. These strata, based upon the crystalline rocks of the southern steppes, constitute a greatly disturbed region, and, owing to numberless convolutions, present the most remarkable contrast to the horizontal deposits of Central and Northern Russia. It is therefore difficult to observe the order of succession; but, owing to our previous acquaintance with the types in their normal condition, we were enabled to trace the sequence, from conglomerates and sandstones at the base of the carboniferous limestone, up to the equivalents of the Magnesian Limestone or Zechstein.

Whilst thus briefly alluding to this tract, I must pass, for a time, from my own labours, and those of my friends, of the value of which you must judge when our work is completed, in order to mention the recent appearance of the fourth volume of the splendid work of M. Anatole Demidoff, 'Voyage dans la Russie Meridionale,' which is entirely devoted to the description of the carboniferous region of the Donetz. M. Le Play, an eminent French engineer, happily selected by M. Demidoff to ascertain the true mineral wealth of the tract, and to describe its physical and geological structure; has produced a work so replete with well-digested details, collected, not only from observation of the natural features of the region and the mines which have already been commenced in it, but also by numerous borings carried on by himself or his assistants during a period of three years, that the Imperial Government will doubtless feel grateful to the accomplished patron who has so liberally fostered these inquiries.

In a large geological map, in which the demarcations of the carboniferous and crystalline rocks, and also of the overlying secondary and tertiary deposits are given, M. Le Play has grouped under darker colours such parts of the tract as are known to be productive of coal, to distinguish them from those in which the mineral has not yet been discovered. This method, doubtless, carries with it a certain amount of information, but it is deficient in stratigraphical meaning, for some of the beds so marked are higher than others; in some the coal is interlaced with limestone and in others it is almost entirely subordinate to sandstone and shale; in one tract anthracite exclusively prevails, in another bituminous coal. By reference, however, to the explanation, and to a series of tables, this defect is obviated. These tables are, in fact, perfect models for the practical mining engineer; they give at one view the direction, inclination, thickness and quality of the coals at each locality, also the characters of the associated strata, as well as the state of the works, and their produce at each mine. To these is added another set of tables, in which the chemical analysis of the coals from forty-three different places is given by M. Malivaud, another agent of M. Demidoff.

Into such details, valuable as they are, it was not our province to enter, and I will now, therefore, merely offer a few remarks explanatory of those points in which the geological conclusions of my friends and self either agree or are at varience with those of M. Le Play.

Certain fosssils which he had brought to France, and which we inspected before our journeys to Russia (1840), first led us to believe, that these coal-beds are subordinate to the carboniferous limestone. Of this, indeed, there could be no doubt, for the species were, to a great extent, the very same as those with which we were familiar in rocks of that age in western Europe. On interrogating M. Le Play, however, we could not ascertain that he had arrived at any defined idea of a succession of strata, derived either from the stratigraphical order of mineral masses, or from their imbedded organic remains. In fact, he then distinctly acquainted us with what has now appeared in his work, that, owing to the disturbed and convoluted condition of the strata, the want of persistency of mineral characters, and the apparent existence of similar species of shells throughout the series, it was impracticable to assign a base line to the deposits, or to trace their uppermost limits, still less a passage into any superior formations.

Now, as we have ventured to effect these objects, with what success we must leave others to decide, I will here briefly state why I conceive M. Le Play did not arrive at similar results; although he had in his own hands some means of proof, which through the short time at our disposal, we never obtained.

No geologist, however practised, can, I venture to say, explain the structure of any complicated part of a distant country, unless he has made himself master of the clear succession of its normal formations. Long as I have been occupied in the study of the Palæozoic Rocks, I am confident that had my friend and myself been thrown suddenly into the chain of the Donetz, and had been desired at once to unravel its complexity, we should have reached no other geological result than that to which M. Le Play has attained, viz. of stating that the coal-seams are, as a whole, subordinate to the carboniferous or mountain limestone. We had, however, by two years of extensive comparative researches, obtained an intimate acquaintance, not only with the older Palæozoic rocks of Russia generally, but, in reference to the carboniferous system, had convinced ourselves, that, throughout the enormous area over which we had traced it, the upper or coal group of western Europe was absent; and that the calcareous or lower group, occupying the whole carboniferous horizon, was divisible into three stages, by help of certain fossils characteristic of each. Again, we had ascertained, by numerous sections on both flanks of the Ural Mountains, that in becoming part of a mountain mass, this system, so uniform and so peculiar over a space as large as an ordinary European kingdom, put on many of the features which are so well known to those who have studied the carboniferous limestone only in the western parts of Europe.

We further learnt, that, in the absence of any deposits to represent our great coal-fields, the carboniferous system was succeeded, in ascending order, by a vast series of red and cupriferous deposits, to which we have assigned the name of Permian. It will not, therefore, be arrogant on our part to say, that we entered upon the examination of the territory of the Donetz, in the possession of elements of comparison which no previous travellers had acquired.

Knowing, from the maps and instructions furnished to us by the Imperial Administration of Mines*, that the major axis of this tract and the main direction of the strata trend from west-nort-west to east-south-east, we resolved, after terminating our researches in Southern Russia, to examine the chain of the Donetz in parallel lines transverse to its general strike; and, by carrying out this scheme, we arrived at the conclusion, that the oldest member of the series occupies its southern frontier, and that, after a multitude of flexures, the central strata dip under a limestone charged with Fusulinæ, fossils which we had invariably found in the uppermost bands of limestone; the whole group being surmounted in the valley of Bachmuth by the equivalents of the Permian system. One striking deficiency, however, attached to our reconnoissance, and fortunately it has been supplied by M. Le Play himself. Those members of the Geological Society who heard our memoirs read, will recollect the importance we attach to the presence of the large *Productus giganteus*, as uniformly characterizing (over vast regions in Russia) the lowest beds of the carboniferous limestone: and, we now learn from M. Le Play, that this fossil, of which he collected many individuals, occurs in the southern part of the region; our idea is thus completely confirmed of an ascending section from south to north.

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* The instructions of General Tcheffkine, the works of Captain Ivanitzki, and a map by Colonel Olivieri. See Journal des Mines, &c.

In fact, the examination of the carboniferous region of the Donetz is one of the best examples that can be adduced, of the paramount importance to the practical miner of the close study of organic remains, in reference to the normal position of the strata; for, throughout deep sections in the northern part of the same territory, there is not a trace of this great Productus, whilst all the fossils of the middle and upper strata are present. Any one, therefore, who had felt as confident as we do, that this remarkable fossil was as clear an indication of a lower band as the *Spirifer Mosquensis* and Fusulinæ are of an upper, could not have doubted of the general relations and order of the strata in the chain of the Donetz.

Agreeing in the correctness of the general parallel which M. Le Play has drawn between the deposits of the Donetz and the carboniferous limestones of Great Britain, Belgium and France, I do not believe that beyond this point his comparisons can be sustained. The coal fields, for example, of the Low Countries and of Düsseldorf, with which I am well acquainted, do not offer, as he supposes, an analogy to those of the Donetz; for in the former, coal-seams are in no instance interstratified with the Mountain Limestone series of English geologists, but are invariably superposed to it. Again, in the Prussian and Belgian provinces, the mountain limestone with sands and shale, but void of coal, reposes on a fine succession of Devonian and Silurian rocks, loaded with typical fossils; whilst the group of the Donetz, exclusively carboniferous to its base, rests at once either on very ancient cristalline rocks, or upon porphyries and other eruptive masses, to the agency of which is to be attributed the extraordinary contortions into which the strata have been thrown. The true analogy, therefore, of the coal of the Donetz, considered in reference to other deposits of the same age, is to be found in the north-western English districts of mountain limestone, in which several workable seams occur; though in this comparison it must be stated, that the Russian beds contain much more coal than the British strata. But even if we admit that, to some extent, there is a similarity in the carboniferous rocks of South Russia and the Low Countries, in their being both flanked by cretaceous deposits, we must also not omit to recognise a great discrepancy, through the presence in the one case of overlying strata of the age of Zechstein, and in the other by the total absence of that deposit.

To considerations of theoretical importance concerning the changes which the surface of Southern Russia may have undergone, and which are ably put forth by M. Le Play, I will not at present advert; reserving my views on these points for the concluding chapters of the work upon Russia, when all the elements which my friends and myself can bring together shall have been laid before our readers, to enable them to see the grounds upon which the conclusions are based.

For the present, then, I take leave of this volume of M. Le Play, which, though it contains some views of positive geology from which I differ, must still be regarded as an important addition to the records of physical science, and as possessing much more the character of a good monographic description of a given tract in Russia, than anything which, from the extensive nature of our researches, my friends and myself will ever be enabled to offer.

Permian Rocks.—On its eastern frontier, far removed from the tract to which allusion has been made, the uppermost member of the carboniferous limestones of Northern and Central Russia, distinguished by the presence of multitudes of the foraminifer *Fusulina,* is succeeded by the most widely spread of the Russian systems; to which, from its occupying the whole of the ancient kingdom of Permia, we have assigned the name of Permian. You have been told, that this vast group is composed of limestones, marls, great masses of gypsum, rock-salt and repeated alternations of cupriferous strata; and that it contains a flora and a fauna of characters intermediate between those of the Carboniferous and Triassic periods. The shells are, to a great extent, those of our Magnesian Limestone or Zechstein; and, like the conglomerate of that deposit near Bristol, the Permian rocks are distinguished by the presence of Thecodont Saurians. The interest attached to these vast deposits, which have been spread out to the western flanks of the Ural Mountains, is increased by the inferences which have been drawn, that springs and currents holding much copper in solution must have flowed from the edges of that highly mineralized and metamorphic chain, while the Permian strata were accumulating. But the great value of having worked out a fuller and richer type of a group of strata between the Carboniferous and Triassic epochs than any which exists in Western Europe, will be found in the fossil shells, the plates of which are already far advanced; for, with some species hitherto known in the Zechstein of Germany and Magnesian Limestone of England, we shall publish others which are identical with or analogous to forms that occur in rocks occupying the same geological position in North America, of which I will speak hereafter, and concerning the age of which great doubts had prevailed.

In America indeed, as in Russia, these beds have been compared with every deposit, from the coal to the Keuper inclusive, whilst in our work they will be shown to have no connection with the New Red Sandstone or Triassic group, but to occupy a definite position, truly intermediate between that system and the carboniferous. At the same time it is manifest, that although they overlie and are, as they ought to be, very distinct from the Carboniferous system, yet they contain some species of shells which occur in that division. Thus it will be made evident, that after all there now remains scarcely any real difference of opinion on this head between Mr. Phillips and myself (to which I alluded last year); for I learn from him, that in England the analogy between the fossils of the Magnesian and Mountain Limestone obtains to a far greater extent than could be supposed from any published catalogues. I trust, therefore, that the ensuing year will not be without its fruits in the production of new works on the shells of the Magnesian Limestone of our own country; and I am glad to have it in my power to inform you, that Mr. King, the Curator of the Natural History Society of Newcastle-on-Tyne, is preparing some excellent materials for this purpose.

A better acquaintance with the Permian fossils, particularly the prevalent Mollusca, induces me, notwithstanding the arguments I employed last year, to infer that this deposit, so naturally connected through its characteristic fossils with the Carboniferous strata, must be classed with the Palæozoic rocks*. The physical structure of Russia is also greatly in favor of this view; for, in large portions of that country, there is an entire absence of the great rupture between the Carboniferous rocks and the Magnesian Limestone, which is so prevalent in the British Isles. The examination of rocks of this age in North America, to which I shall hereafter advert, leads to the same opinion; viz., that the Permian deposits must be viewed as the fourth or uppermost stage of the Palæozoic series, notwithstanding the occurrence of Thecodont Saurians.

Jurassic, Cretaceous and Tertiary Strata.—Overlappod as these Permian deposits are, in certain tracts of Russia, by red and white marls and sands, we are not positively prepared to state (in the absence of decisive fossil evidences) whether some of them may not represent the Trias; though the fossiliferous limestone of Monte Bogdo, in the steppe of Astrachan, is probably of this age. With the Jurassic strata, however, which follow, and which occur at intervals from 65° north latitude to the countries south of the Crimea, we made ourselves well acquainted. Should the word *Jurassic* grate upon the ears of Englishmen, it is impossible to deny that this geographical term is much more applicable to the strata in question than our own word "Oolitic," which implies a structure scarcely ever seen in beds of this age in Russia. Whether examined at Moscow or on the Lower Volga, they consist of black shales and ferruginous sands, occasionally containing calcareous cement-stones, and thus they present a general lithological analogy to the Lias; a formation, however, which is not represented in Russia, for the fossils are all referable to the groups extending from the Inferior to the Upper Oolite, and many of them are identical with British species.

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* My companions, M. de Verneuil and Couut Keyserling, have long entertained the same views as Mr. Phillips on this point.

I must now pass over the Cretaceous deposits which occupy such broad spaces in Southern Russia, the Lower Tertiary beds, some of which, on the Volga, might almost be mistaken for those of Bognor and the London basin, and also the strata of the Miocene age, whish occupy wide tracts in Volhynia and Podolia, merely remarking by the way, how the recent discovery in limestone of an herbivorous Cetacean is a very important adition to the fauna of that period.

Superficial Detritus—Ural Mountains, &c.—The discovery of accumulations, containing recent shells of Arctic species, considerably to the south of Archangel, was important, as showing that the great northern blocks, which overlie them there, were brought to their present position during a period which differed remarkably from the one preceding it, and also from that which has followed it, in the very general prevalence of a colder climate over large spaces; thus enabling us very safely to infer, that the great erratics of the North were transported in icebergs, which floated in an arctic sea and occasionally grated along its bottom. But this operation, gigantic as it was, had its well-defined southern limits, as is beautifully proved by the general survey of the Russian Empire; in the southern half of which all such erratics cease, and fine black slime (tchornoizem) takes their place. Wherever the recent accumulations of the steppes indicate the desiccation of brackish seas, which like the present Caspian were inhabited by Mollusca requiring a warmer climate, then is there also a total absence of great boulders. On this point I would further beg to remind you, that in our examination of the Ural Mountains, even up to 60° north latitude, my companions and myself could not trace any evidence whatever of boulders having been transported from these mountains to great distances upon their flanks; although the peaks rise to heights of 5000 and 6000 feet above the sea, and the chain extends from north to south through eighteen degrees of latitude. In every portion of the Ural Mountains, and on both their Asiatic and European flanks, the detritus is of a purely local character; and in it are occasionally entombed the bones of the Mammoth, *Rhinoceros tichorrhinus,* and other extinct quadrupeds, mixed up with gold sand and gravel. Transporting ourselves to the south of Russia, we find the upper portion of the cliffs of the Sea of Azof composed of local detritus and clay equally charged with the same remains.

The general examination of Russia proves in the most emphatic manner, that the central masses of her continent, though exempt from all plutonic ageecy, have undergone grand but tranquil oscillations which have scarcely at all disturbed the physical outlines of the ancient bottoms of the sea—oscillations which have operated in a similar manner over this vast space from the remote Silurian age, to the close of the period antecedent to the historic æra. This survey has also taught us, that the great Russian continent is surrounded by rocks of igneous origin, the eruptions of which have corrugated and diversified certain portions of the surface at different periods.

On her eastern or Asiatic side it has been the wish of my friends and myself to endeavour to read off in the Ural Mountains the effect of such derangements, and to trace the sedimentary deposits of Russia through the mazes of that band of great disturbance. Having so recently laid before you the outline of our views concerning this chain, and being aware that you will soon be in possession of much additional knowledge respecting it from the pen of the illustrious Humboldt, I will confine myself to a single paragraph, by saying that our chief object was to refer those broken and altered masses to their normal types.

We found this highly metamorphic chain, so rich in metalliferous masses, to consist essentially of Silurian, Devonian and Carboniferous rocks, the fossils of which we traced at intervals notwithstanding the countless ridges of igneous matter and the highly crystalline structure which has been communicated by its eruption to the contiguous sedimentary strata. A short period only has elapsed, since rocks having quartzose, micaceous and gneissose characters would not have been admitted into the same category with strata containing organic remains; but the theory of metamorphism, founded on patient observation and comparison, has prevailed over ancient doctrines. The sedimentary rocks of the Ural being palæozoic, must indeed, be viewed as among the most ancient of the metamorphic class. Many other crystalline chains are of much more recent age, as long ago, indeed, shown by M. Leopold Von Buch and other observers. Of the truth of this I will first adduce as proofs the Caucasian chain which bounds the Russian Empire on the south. The second illustration of metamorphism will be derived from recent researches in the Western Alps.

BRITISH ASSOCIATION.

The annual assemblage of the Members of this Association took place in Cork, on August 16, 1843, when the meeting of the General Committee took place, the Earl of Rosse presiding.

Colonel Sabine read the Report, which was, however, entirely destitute of interest on any subject connected with geology, and hence we pass it over in silence.

At a subsequent meeting of the General Committee the following grants were proposed and carried, amongst a number relating to other departments of science.

T. Oldham, Esq., for experiments on subterraneous temperature in Ireland	£10
Marquis of Northampton, for making colored drawings of railway cuttings	£100
Professor Owen, for investigation of the fossil fishes of the lower Tertiary strata	£100
Rev. W. Whewell, for completing level marks in Somerset and Devon	£20
David Milne, Esq., for establishing standard level marks on the coast of Scotland, with reference to the direction of shocks of earthquakes	£20

The above grants are for entirely distinct purposes from any of those made at the Manchester meeting in Juue, 1842*.

The following papers were submitted to the Geological Section during its session, over which the following committee was appointed, viz.

President—Mr. Griffith.

President for Geography—Mr. R. I. Murchison.

Vice-Presidents—Messrs. W. Hopkins, C. Lyell, J. Taylor.

Secretaries—Messrs. F. Jennings, H. E. Strickland.

Committee—Marquis of Northampton, Major S. Clerke, Mr. E. Forbes, C. Y. Haynes, M.D., Mr. J. Heywood, Lieut. de Kokscharoff, Mr. C. B. Newenham, Prof. Owen, Messrs. J. Phillips, R. Taylor, H. Townsend, R. W. Townsend, Rev. D. Williams, Messrs. E. Winterbottom, D. Gilbert, Sir R. Steele, Sir. C. Lemon, Messrs. W. Hatfield, E. W. Binney, H. N. Nevins, T. Oldham.

"*On the structure of the Appalachian Mountains*," by C. Lyell, Esq., F.G.S.

Mr. Lyell exhibited and explained a transverse section of the

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* Geologist, vol. i. p. 234.

Appalachian chain of Mountains in North America, communicated by Professors W. B. and H. D. Rogers, and intended to illustrate the law of structure prevailing throughout that chain.

"On the Phenomena and Theory of Earthquakes, and the explanation they afford of certain facts in Geological Dynamics," *by* H. D. and W. B. ROGERS.

The authors first proceed to examine the *phenomena attending earthquakes* commencing with the following propositions:—1. Earthquakes consist essentially of a wave-like motion of the whole solid ground. 2. The earthquake undulation is not simultaneous throughout the whole area agitated, but is *progressive,* and propagated with enormous velocity. 3. The undulation is transmitted sometimes in the manner of an elongated, curved or nearly straight belt, moving parallel to itself, and sometimes in the manner of a dilating elliptic or circular zone. The author then described earthquake phenomena as divisible into such as are of invariable occurrence, and therefore characteristic, and such as are only occasionally witnessed. The *characteristic phenomena* consists as announced by the Rev. John Mitchell, of Cambridge, in the Phil. Trans. for 1760, of a peculiarly rapid *undulation,* or wave-like motion of the ground, and a sharp vibratory jar, or *tremor*; the undulating generally extending further from the source of the earthquake than the tremor. The *occasional phenomena,* observable only when the earthquake is violent, are a deep rumbling and grating noise, an alternate opening and closing of parallel fissures, and the escape of steam and sulphureous and other vapour, and hot water, from those fissures. In confirmation of these observation, the author cites the earthquake of Conception in 1835, described by Captain Fitzroy, and that which visited the island of Hayti, in May 1842. As examples of the second proposition, they mentioned the earthquake of Lisbon, and two others which have occured during the present year. The first of these took place on the 4th of January, and was felt along the valleys of the Mississippi, from the military posts on the frontier west of that river, to the coast of Georgia, and from 31° N. lat. to Lowa, a distance of about 800 miles in each direction; it occurred about 9 P.M., and was sufficiently voilent to excite some alarm; throughout the region agitated the motion was both undulating and vibratory. From a comparison of the dates of the shock at twenty-seven different localities, it appears to have been simultaneous along a certain line stretching in a N.N.E. direction from the western margin of Alabama to Cincinnati, a length of more than 500 miles; it was also synchronous along other lines parallel to this; places to the westward experienced the shock earlier than the other localities, the intervals being in proportion to the distance. From these facts the authors infer *"that the area agitated at a given instance was linear, and that the earthquakes moved from N. N.E. to E.S.E. in the manner of an advancing wave.* The velocity with which the shock was propagated appears to have exceeded thirty miles per minute. The second, or *Guadaloupe earthquake* was felt along the Winwood Island, at Demerara, Guiana, Bermuda, and most of the principal cities of the Atlantic seaboard of the United States, from Savannah to New York. Its range, in latitude, amounting to 35°, and in longitude to 23°, the longest diameter of this elliptical area extending from Demerara to New York, was about 2,300 geographical miles; and its breadth, from Bermuda to Savannah, 700 miles. The principal intensity of the disturbance was confined to a nearly N. and S. line, or belt, or embracing St. Vincent's, St. Lucia, Martinique, Dominica, Guadaloupe, and Antigua; and thence prolonged to the continent of South America, and to Bermuda. Along this curved axis the shock was simultaneous: and from a comparison of observations made at other stations, it appears to have been propagated eastward and westward at the rate of twenty-seven miles per minute. In the second part of their communication the authors propose a *theory of the origin and movement of earthquakes,* as applied by them in explanation of the structure of the Appalachian Mountains. According to this theory, the wave-like motion of the earth's surface during an earthquake is of the nature of an "actual billowy pulsation in the molten matter," upon which they suppose the crust of the earth floats, "engendered by a linear or focal disruption and immediate collapse of the crust, accompanied by the explosive escape of highly elastic vapour." The progressive waves of oscillation thus developed on each side of the axis of disturbance, would move off in parallel order, and form a dilating elliptic zone. Supposing the earth's crust to be ruptured only at a focal point, as in the orifice of a *volcano,* the receding pulsations would be approximately *circular*; whereas, if the line of fracture were greatly elongated, and the pulsations observed but on one side, the advancing belt of waves would appear straight.

The sea-waves caused by earthquakes are described as broad undulations of the water, moving in the same direction with the pulsation of the crust beneath, at the rate of three and a half miles per minute in the case of the New England earthquake of 1756; and at the rate of five miles per minute during the great Lisbon earthquake, the waves succeeding each other at regular intervals of five minutes. Assuming these sea-waves to correspond with the undulations beneath, the authors calculate the *breadth of the crust waves* in the Lisbon earthquake at twenty five miles; and in the earthquake of Conception, where the undulations averaged four per minute, and travelled forward at the rate of forty-two miles in the same time, each wave possessed a breadth of at least ten geographical miles. *The tremor attending earthquakes* is considered as the *effect* of the crushing of the strata during, and caused by the undulations, rather than as the result of waves of vibration, which would be dispersed and destroyed by the broken condition of the materials and their heterogenous composition.

Application of the theory of earthquakes.—From these considerations the authors infer, that when earthquakes produce any *permanent* elevation or depression of the land, the tracts so affected will generally have the shape of elongated parallel belts as exemplified in the Ullah Bund in the Delta of the Indus, the elevation of the coast of Chili, and the local arching of the surface across the bed of a river in Chilli, mentioned by Darwin. Referring to their memoirs on the Appalachian chain, the authors contend that the structure of those mountains (and, by analogy, those of other countries) implies the operation of far greater and more sudden forces than the gentle secular changes observed in modern times; and they consider it impossible to avoid the conclusion, that all the more extensive revolutions of the earth's crust have involved, to a greater or less extent, the *agency of vast earthquake waves.* To the action of these waves, in different geological epochs, they attribute the formation of the vast masses of conglomerate and detrital deposits distributed in the various groups of strata; also the transport of the great northern drift, and the polished and furrowed surfaces of rocks both in Europe and New England.

Major S. CLERKE begged to mention a fact which had come under his own observation. Having witnessed the great eruption of Mount Vesuvius in 1822, it occured to him to ascertain whether any reciprocity existed between that volcano and the small crater of the Solfatara, near Pozzuoli, distant about ten miles, in a line across the Bay of Naples. On proceeding to the latter place he was informed by the Custode, an intelligent man, that since Vesuvius had been in activity, the Solfatara had subsided. Major Clerke, on a personal examination of the aperture forming the vent of the Solfatara, found this to be the fact, the usual eruption and loud noise having ceased. When Vesuvius relapsed into quiet, the Solfatara resumed its activity.

An Account of the late Earthquake at the Islands of Antigua and Guadaloupe, on the 8*th of February,* 1843, *by the* Hon. Capt. CARNEGIE, M. P.

The earthquake is described by the author of the communication as having been felt, generally among the Leeward Islands, but more particularly at Antigua and Guadaloupe. At both these islands the shock took place at twenty minutes before eleven o'clock, A.M., and it does not appear to have been preceded by any of the usual signs of earthquake; the weather was clear and fine, the sea-breeze blowing as usual and the inhabitants engaged in their daily avocation. At Antigua the earth heaved and undulated suddenly; the hills oscillated, and hugh masses of rock were detached from their summits and precipitated into the valleys; large fissures opened in the ground and closed immediately. The water in the harbour whirled round and round, enveloping the islands in a cloud of dust, which shut them from view, and in the space of two minutes and a half all Antigua was laid in ruins. In this island only eight persons lost their lives, owing to the black population being employed, as usual, among the canes, but the loss of property was immense. At Point-à-Pitre, in Guadaloupe, the effect was much more fearful. In magnitude, this was the second town in the West India islands; it was situate upon a piece of low ground surrounded on three sides by the sea, and entirely built of stone to avoid the effect of hurricanes. At the time of the earthquake, most of the inhabitants appear to have been at their late breakfast, in consequence of which 4,000 perished among the falling houses or in the fire which broke out immediately after; this destruction of the whole town was so complete, as to present, after the earthquake, the appearance of a vast stone quarry. The landslips were very numerous, and all the springs in the vicinity of Point-á-Pitre were instantly dried up. The shock was felt slightly as far north as Washington and Bermuda, and southward to Demerara, travelling in N.N.E. and S.S.E. direction; several slight shocks were subsequently felt at different periods.

On the Direction of the Currents, by which certain Gravel Hills and Erratic Blocks were distributed in the north of the counties of Mayo and Sligo, by R. GRIFFITH, ESQ.

The erratic block deposits of Ireland were distributed by a force moving generally in a north-west and south-east direction, modified, however, in many localities by the opposition of mountain ridges and deep valleys. This deposit consists usually of clay and rolled fragments of limestone, derived from the carboniferous rocks, which occupy two-thirds of the island; and these materials seldom exhibit any trace of stratification. It frequently exceeds one hundred feet in thickness, and occupies all the valleys, and even the interior of the mountains, occurring either in one thick mass, or in elongated ridges, known by the name of *Eskers*. The prevailing direction of the mountain ridges of Ireland is north-east and south-west, that is, at right angles to the supposed direction of the current by which the drift was deposited; in consequence of this, the deposits of detrital limestone are distributed only on the north-western declivities of the hills. In the granite and slate hills of Wicklow, the limestone gravel has passed through the valleys of that range, and formed a valuable deposit to the east of Mount Leinster, spreading over the Cambrian slatse, east of Newtown Barry, in the county of Wexford; the same facts may be observed in the Slievebloom mountains, in the Galtees, and the Monavullagh mountains. The summit of Blatinglass Hill, on the northern edge of the Wicklow granite district, is 1256 feet above the level of the sea; to the eastward of this hill there is no limestone gravel, whilst it is abundant on the lower hills, and in the valleys to the south; to the north of this hill the gravel is seen at an elevation of 880 feet, from which Mr. Griffith infers that the transporting force did not operate at an elevation exceeding 1000 feet. Besides the limestone gravel, boulders of granite and conglomerate are occasionally found scattered on the surface, and not included in the clay drift; from the peculiar composition of the granite of certain districts, it is not difficult to detect the locality from which these blocks were derived, and hence the author has been enabled to detect small boulders of the Connemara granite, in the valley east of the Slievebloom mountains, also in King's County, and in the limestone district of Galway; indicating a north-west and south-east direction, in the line of transport, throughout a very large portion of Ireland. This direction, however, has not been universal. In the counties of Sligo and Mayo there are two ranges, namely, the Ox and the Curlew mountains, having nearly parallel directions from north-east to south-west. The Curlew consists of reddish-brown sandstone, connected with the upper Silurian system; the Ox mountains, situated about twelve miles north of the Curlews, are composed of mica slate and granite, whilst both ranges are flanked by strata belonging to the carboniferous system. South of the Curlews the gravel contains limestone only, and the *eskers* extend in a northern direction up the southern declivities of the hills; towards the summit, boulders of yellowish-gray limestone are scattered on the surface, while downwards to the limestone valley, on the northern side, the surface is thickly covered by very large boulders of reddish-brown sandstone, sometimes weighing several tons, the largest occurring nearest the ridge; towards the base of the Ox mountains these boulders are still very numerous, but much diminished in size. Ascending the mica-slate ridge of the Ox mountains, small boulders of red sandstone still occur, together with small *eskers* of limestone gravel, sometimes remarkable from their forming ridges *directly across the valleys*, as in the valley of Lough Easky. To the north and south of this lake the rock is mica slate, but at the lake itself there has been an extensive protusion of granite. In the line of the road to Easky, two miles south of the lake, the valley is crossed at right angles by two *eskers*, composed of rolled fragments of limestone and some clay; they are thirty feet in height, and very steep; their elevation above the plain, from which they have apparently been derived, is 250 feet; numerous large boulders of mica slate are strewed over their surfaces, but none are intermixed with the gravel. Approaching Lough

Easky, there is an elongated sinous *eskers* nearly parallel to the line of the valley; it is composed altogether of pebbles of quartz and mica slate, mixed with sand and clay, all derived from the adjoining mountains, thus forming a moraine, which may be accounted for on the hypothesis of Agassiz. Following the valley of Lough Easky to the sea-shore, a distance of ten miles, the entire surface of the limestone country is thickly strewed with large boulders of granite; some of these close to the shore are of enormous dimensions; one of them being about one hundred tons in weight. They occur also along the whole line of coast westward, from Easky to Erris, in Mayo, and with them a few rolled blocks of mica slate, occasionally, but no limestone, though the entire district, which is comparatively low and flat, is composed of strata belonging to the carboniferous system. These granite boulders are precisely similar in composition to the granite of Lough Easky, Lough Talt and Foxford. Taking all these facts into consideration, it is evident that in these localities the currents must have been from the south, and not, as in other districts of Ireland, from the north-west to the south-east.

On the Lower Portion of the Carboniferous Limestone Series of Ireland, by R. GRIFFITH, ESQ.

This communication was accompanied by numerous large coloured sections, which illustrated the author's minute descriptions of particular localities. The carboniferous rocks, as subdivided by Mr. Griffith, are in descending order as follows:—1. *The upper limestone* forms the base of the millstone grit series; it averages 600 feet in thickness, and is very fossilliferous in its upper part. 2. *The Calp series* consists of a succession of dark gray slates alternating with dark impure limestone; beds of yellowish sandstone occupy the middle of the series, which is usually 1000, and occasionally 1800 feet thick. The shales of this division contains numerous fossils, especially Posidoniæ, of which there are six species. 3. *The lower limestone* occupies a very considerable portion of Ireland, and contains a great abundance of fossils; its average thickness is about 1000 feet. The carboniferous slate and yellow sandstone were formerly considered as part of the old red or Devonian system, but from the affinity of their fossils to those of the carboniferous deposits, Mr. Griffith has been induced to include them in the latter system. 4. *The carboniferous slate* contains 274 species of fossils of which 262 are common to the upper limestone and 65 are found in the Devonian deposits. 5. *The yellow sandstone* is most fully developed in the northern districts of Ireland, and sections of it are seen on the north coast of Donegal Bay, the northern shore of Lower Lough Erne, and in the counties of Fermanagh, Mayo, and Londonderry. On the north coast of Mayo it rests on beds of the old red sandstone, and attains a thickness of 1460 feet. At Lough Erne the mica slate is covered, unconformably with 50 feet of red conglomerate, succeeded by yellow sandstone, shale, &c. 150 feet thick, containing calamites and the *Modiola Mc Adami.* This series of shale and sandstone is continued upwards, through a space of 2900 feet, to the base of the lower limestone: it is impossible at this locality to draw the line of separation between the yellow sandstone and carboniferous slate, but the latter probably includes about 1200 feet of the whole mass. At several other localities the yellow sandstone also rests unconformably upon red conglomerate, apparently belonging to a distinct epoch. The most remarkable and extensive district of yellow sandstone in Ireland occupies the whole of the northern and eastern shores of Lough Foyle, in the county of Londonderry; its lower beds are a conglomerate, formed from the mica slate upon which it rests; they are 600 feet thick, and not fossilliferous. The second division of the rocks in this district, which is 500 feet in thickness, contains numerous beds of dark shale and grayish sandstone; and the uppermost consists of red, greenish, and yellow shales, with numerous thin bands of nodular limestone and red sandstone, passing into quartoze conglomerate, resembling the ordinary old red sandstone. These strata are succeeded by beds of grey shale, white sandstone, and dark gray shale, which in this locality forms the uppermost portion of the series. In the second of these divisions the fossils are numerous, including seven species of Cythere and the *Modiola McAdami,* together with remains of fish belonging to the genera Gyracanthus, Ptychacanthus, Leptacanthus, and Holoptychius. In the third division, which is about 1400 feet thick, fossils occur only in the conglomerate limestone ; they consist of several species of Orthis, Spirifer, &c. This deposit differs in some respects from the usual appearance of the yellow sandstone and carboniferous shales, but from the evidence of the fossils Mr. Griffith is induced to refer it to that deposit. The last important locality described by the author is the carboniferous valley of Ballinamore, in the county of Leitrim, between the old slate range of the Cairnclonhugh mountains of Longford and the millstone grit district of Slieve-aneerin, in the county of Leitrim. In this valley the slate rocks are succeeded, unconformably, by sandstone conglomerates, impure arenaceous limestone, and dark gray shale with thin beds of sandstone, altogether about 70 feet in thickness. These are succeeded by 150 feet of yellowish quartoze sandstone, and 100 feet of limestone, dark shale, and calcareous sandstone, above which the carboniferous slate, lower limestone, calp shale, and upper limestone, occur in regular succession up to the millstone grit of the Slieve-aneerin mountains. In the lowest calcareous strata of this locality were discovered numerous species of Cythere, the *Modiola Mc Adami,* the *Oracanthus Milleri,* and other ichthyolites, and several plants. The limestone above the shale also contained numerous plants, and abundance of *Orthis crenistria,* &c. in its upper beds. The carboniferous slate and other beds contained the Fernestellæ and other fossils in abundance. At Cultra on the southern shore of Belfast Lough, are a series of strata formerly considered by the author as a part of the new red sandstone, and magnesian limestone group, but from an examination of the fossils last year, he has ascertained that they are coeval with the deposits of the valley of Ballynascreen. The beds consist of red sandstone and contain casts of four species of Cucullæa, *Pullastra antiqua,* several Nuculæ, and a Cythere. The shales overlying these beds contain in abundance the scales of *Holoptychius Portlockii,* together with fifteen species of *Cythere, Modiola McAda mi, Orthoceras regulare, Cypricardia socialis,* and five species of Cucullæa. In the southern portion of this section, commencing on the shore of Strangford Lough, the limestone of Castle Espie is shown, also resting unconformably on the old slate. It contains *Actinoceras Simmsii, Producta gigantea* and *latissima, Orthis cylindrica, Spirifer imbricata* and *glabristria,* and *Cyathophyllum fungites.* The limestone is succeeded by various coloured sandstones, extending northward to Scrabo Hill and the old slate ridge of the Ards peninsula. From a review of all these sections, and a careful comparison of the lists of fossils obtained from them, Mr. Griffith has been induced to class these deposits with the lowest members of the carboniferous series.

"Report on the Excavation made at the Junction of the Lower New Red Sandstone with the Coal Measures at Collyhurst, near Manchester," by E. W. Binney, Esq.—The rocks of the new red sandstone series, in the vicinity of Manchester, are described by Mr. Binney as occupying hollows previously formed by great dislocations in the carboniferous strata. Along the valley of the Irk the upper new red sandstone, the magnesian limestone, and the lower new red are exposed in succession; but as the absolute point of contact between the coal measures and lower new red sandstone had not been seen, a deep cutting was made at a place called Tinker's Brow, about one mile N. E. of the Manchester Exchange. The different beds were thus described by Mr. Binney in descending order. 1. *The Till,* locally known as *marl* and *brick clay,* containing blocks of granite, sienite, porphyry, greenstone, basalt, and various other igneous rocks; clay slate, Silurian Rocks, mountain limestone, chert, millstone grit, iron-

stone, &c., from the coal series, magnesian limestone, and the waterstone of the upper new red. These fragments are of various sizes, the largest being five tons in weight, and are mingled together without any order of deposition: near the edge of the great fault they are larger and more numerous than in any other part of the till near Manchester. Those boulders, such as the granites, porphyries, and hard slate rocks, which do not occur *in situ* within 100 miles of Manchester, are mostly well rounded, and some are scored with striæ and polished; whilst those found in the neighbourhood, such as mountain limestone, &c. are less striated and polished, and many are quite angular. Although the boulders occur in the clay, without any distinct lines of deposition, there occurs at one point a deposit of fine laminated silt and sand, ten or twelve inches thick, and about a yard from the bottom of the till, which is twenty-one feet in thickness, and rests on an uneven surface of lower new red sandstone, evidently water-worn; and in some places holes two or three feet deep being found occupied by the till. 2. Lower new red sandstone; composed of dark red sand, variegated by patches of a yellowish-drab colour; its thickness is full forty yards; the main dip is to the S. W., at an angle of 16° to 18°, but it has also a considerable inclination to the N. W. No fossil remains have been found in it. 3. *The Coal Measures*; consisting of a bed of salmon-coloured argillaceous shale, thirty feet thick, containing impressions of *Neuropteris cordata*, and many common coal plants. The coal measures were partly elevated before the deposition of the new red sandstone formation, but it is evident that the latter have been raised by forces which have subsequently elevated the coal measures, as the similarity of dip in both strata testifies.

On certain Movements in the Parts of Stratified Rocks, by J. PHILLIPS, ESQ. F.R.S.

Mr. Phillips stated that for many years the attention of geologists had been called in a very essential degree to the internal structure of rocks; but notwithstanding the advance made by Prof. Sedgwick and Mr. Hopkins, there were points still remaining to be investigated, before mathematicians could explain the force by which these phenomena had been produced; because any such explanation must be based upon data afforded by the actual constitution of the rocks themselves. Twenty years since he had observed such remarkable symmetry in the crystalline forms of prismatic masses of slate in Westmorland, that he had measured their planes, and satisfied himself that they were not of the nature of ordinary crystallization, and that the term, crystalline structure, as usually applied to them, was by no means legitimate. In order to understand the nature of the mechanical forces which have produced the cleavage, it is important to study it in its relation to every form of strata. Where the contortions do not effect the cleavage planes, it is evident that they were first formed; the joints and fissures which interrupt the cleavage but do not disarrange it, were probably posterior, like many of the faults which interupt the strata and cut off the cleavage. When layers of concretionary iron-stone occur in slaty rocks, the cleavage planes are arrested and "troubled" in their passage through them, from which it appears that the nodules had become solid previously to the strata being divided by the planes of cleavage. Several attempts had been made to imitate cleavage structure. Mr. Fox, of Cornwall, had caused electric currents to pass through moistened clay, and had thus produced fissures parallel to the bounding surfaces of the mass and this illustration Mr. Phillips considered very important, but incomplete. The cleavage planes of the slate rocks of Wales were, he stated, always parallel to the main direction of the great anticlinal axis, but were not affected by the small undulations and contortions of those lines. In North Wales they maintain the same direction for fifty miles, not varying more than two or three degrees, which might be owing to local causes, such as the movement of masses by gravity at a period subsequent to the formation of the cleavage. In making observations upon the cleavage, care must be exercised not to confound with those phenomena the marks produced by the mechanical movement of one rock upon another. The shells in slaty rocks were generally distinctly marked by ferruginous lines, caused by their decomposition, and the form of their outlines was often remarkably changed. The Leptænæ in North Devon occasionally assumed the form of Nuculæ, and the Spirifers were crumbled up, or else extremely attenuated. The Trilobites of the Llandeilo flags were found in three distinct forms arising from the distortion taking place in a longitudinal, transverse, or oblique direction; this seemed to be the rusult of a "creeping" movement of the particles of the rock along the planes of cleavage, the effect of which was to roll them forward, in a direction always uniform, over the same tract of country, the movement does not seem to have affected the hard shells, but those which were thin, as also the algæ and trilobites: the latter are covered with little folds, parallel to the wave of motion. In these distorted fossils the amount of movememt might be estimated; as, in the space occupied by a trilobite, it amounts to half an inch. Mr. Phillips had selected these facts, bearing the aspect of real and general laws of structure in rocks, from a series of classed phenomena on the subject, because he regarded them as positive steps towards a mechanical theory of the series of changes by which the structural characters and accidents of position were to be determined.

On the "Permian System" as applied to Germany, with Collateral Observations on Synchronous Deposits in other Countries; showing that the Rothe-todte-liegende, Kupfer Schiefer, Zechstein, and the lower portion of the Bunter-sandstein form one natural group, constituting the upper member of the Palæozoic Rocks," by R. I. MURCHISON, ESQ.

The word *Permian,* when first proposed by Mr. Murchison, was intended to distinguish the natural group of deposits, lying between the well known carboniferous strata beneath and the less perfectly defined trias above it. The author at first suggested that the group (so designated from the ancient kingdom of Permia, which is exclusively occupied by it,) should combine those deposits known under the name of Rothe-todte-liegende (lower new red of England,) Kupfer Schiefer, Zechstein, &c. (magnesian limestone, &c.) Subsequently, however, he was disposed to doubt whether it might not be more correct to class the Rothe-todte-liegende with the coal-bearing deposits beneath it, than with the Zechstein, because the plants of the lower red sandstone could not be distinguished from those of the coal measures. Revisiting Hesse, Saxony, Silesia, the Thuringerwald, and other parts of Germany, Mr. Murchison has obtained what he considers proof that the Rothe-todte-liegende is part and parcel of the same natural group as the Zechstein, and must therefore be considered part of the Permian system. He has also convinced himself that the great deposit hitherto known under the denomination of Bunter-sandstein, Gres bigarré, or new red sandstone, should be divided into two parts, the lower of which ought to be classed with the Permian, and separated from the trias, with which it had been merged. To prove the first of these positions, or that the Rothe-todte-liegende is a part of the Permian group, Mr. Murchison cited the order of succession in numerous sections in Germany, showing an interrupted sequence from the lower red conglomerate sandstone and shale into the overlying Zechstein. It is a question whether the plants of these lower red rocks can be distinguished, as a whole, from those of the subjacent coal measures, plants being, as yet, the only organic remains found in them. From his observations in Saxony, and particularly from an inspection of the fossil plants collected and partly described by Captain Gutbier, Mr. Murchison believes that such a separation exists. Among the coal-plants of Saxony are forms of Neuropteris closely approaching to, if not identical with, those species which occur in the Permian rocks, whilst there is no trace of the common plants of the under-lying coal. Those plants being imbedded in a whitish or cream-coloured finely levigated clay-stone, and their leaves being brought into beautiful relief by being invariably as green as if they had peculiarly and happily dried in an herbarium, form admirable subjects for the most precise distinctions of the fossil botanist. In Silesia (at Ruppendorf, and other localities west of Waldenberg, between Breslau and Glatz) there is a fine development of strata from the base of the Rothe-todte-liegende (where that deposit overlies a productive coal-field based upon true mountain limestone) into other red sandstones and shales, which have a marked aspect, from being interlaced with bands of black, bituminous, thin, flaggy limestone. Though doubts had been entertained as to the age of this limestone, Mr. Murchison does not hesitate to consider it as the equivalent of the Zechstein, and the whole red group of which it forms a member as the counterpart of the Permian system; for, besides its very clear position, this calcareous flagstone contains plants and fishes similar to those of the Permian rocks of Russia. Among the former the *Neuropteris conferta, nov. spec.*, of Göppert, has been identified with the most common fern brought from Rnssia. The most abundant fish is the *Palæoniscus Wratislaviensis.* Ag. On this occasion Mr. Murchison passed rapidly over the zoological proofs that the Zechstein and Kupfer Schiefer of Germany are the equivalents of the calcareous beds of the Permian system of Russia, as these had been gixen in detail in memoirs read before the Geological Society. He stated, however, that his opinion was now perfectly in harmony with that of Prof. Phillips; namely, that the Fauna of the Zechstein, or magnesian limestone, has so much of the same general zoological type as the carboniferous limestone, that it must also form a part of the palæozoic series. Mr. Murchison then proceeded to consider the age of these lower beds of the Bunter-sandstein, which had been hitherto included in the trias, on lithothogical evidence only. They contain no fossils, either in Hesse, Saxony, or Thuringerwald, where the Zechstein and Kupfer Schiefer are most developed; and from all Mr. Murchison's inquiries and observations, it appears that the upper mass only of the Bunter-sandstein contains the remains of animals and plants analogous to those of the Muschelkalk which rests upon it. The footmarks of the Cheriotherium appeared also to be confined to the beds of sandstone, at a very little depth below the Muschelkalk. From these circumstances Mr. Murchison was induced to regard the upper beds alone of the Bunter-sandstein as belonging to the trias, whilst the lower portion, which though generally unfossilliferous, contained in Russia the same groups of fossils with the Permian rocks, he proposed henceforth to separate from the secondary system, and consider it, together with the Zechstein and Rothe-todte-liegende, as the upper member of the palæozoic series supposed to be represented by a thin band of dolomite. The plants of the Permian system of Russia appear, from the opinion of M. Adolphe Brongniart, to possess a peculiar character; but they are still closely allied to carboniferous forms, like the plants of the Rothe-todte-liegende of Saxony; and this evidence is in complete harmony with that afforded by the molluscs, corals and ichthyolites. In conclusion, Mr. Murchison remarked that the English strata ranging under the synonyme of Permian, formed a well-defined tract, separating the coal-fields from the newer deposits of red sandstone and marl; and as the magnesian limestone does not often appear in the form of a continuous deposit, it was the more desirable to give a latitude to this group, and not to define it too narrowly by mere mineral characters. Thus considered, Mr. Murchison believed the Permian system had a real existence in Ireland, being represented by those beds containing the *Productus aculeatus,* and probably also by the red sandstone with the *Palæoniscus catopterus,* at Rhoan Hill, near Dungannon.

Views respecting the cause of theMotion of the Glaciers, by W. Hopkins, Esq. De Saussure had adopted the theory which attributes this motion to the resolved part of gravity acting along the inclined surfaces on which all glaciers in motion are situate; and he explained, also, how the motion would be facilitated by the effects of the internal heat of the earth, and of sub-glacial currents. When the attention of philosophers, however, was recalled, a few years ago, to this subject, and more accurate observations and admeasurements were made, the inclinations of the beds of glaciers were found, in many cases, to be so small (in the glacier of the Aar, for example, not exceeding three degrees), that it appeared extremely difficult to conceive how the force of gravity alone could be adequate to overcome the friction on the bottom and sides of the glacier, and the numerous local obstacles to its movement. Numerous experiments on the descent of bodies along inclined planes had shown that, when the surfaces of the bodies and planes were perfectly hard and polished, no motion would ensue without an inclination considerably greater than that of many glaciers; and, moreover, that the inclination required to produce motion was independent of the weight of the sliding body. These considerations led to the very general rejection of De Saussure's theory, and to the adoption, by many persons, of the *dilation theory,* of which M. Agassiz had been the principal advocate. According to this theory a part of the water produced by the dissolution of the superficial portion of the glacier during summer, passed, by infiltration, into the minute pores and crevices of the glacier, where it was again converted into ice, and by its expansion in the process of freezing produced a *dilation* and consequent motion of the glacier. It was manifest, however, that the frequent alternation of freezing and thawing within the glacier which this theory assumed, could not possibly take place at depths exceeding a very few feet beneath its surface, and therefore could not produce any sensible effect on the motion of the whole mass. This theory presented many other difficulties, of which no adequate solution had been given; and the author could not but consider it as contrary to the most obvious mechanical and physical principles. Another theory had also been put forward, which attributed the motion of glaciers to the expansion of water in the act of freezing, after it had filled, not the minute pores of the ice, but internal cavities of considerable dimensions. But, since the temperature of the glacier at considerable depths must be sensibly constant, how were new cavities to be formed when existing ones had once been filled up? The author, regarding both this theory and the preceeding one as untenable, was thus led to examine how far the apparent objections to De Saussure's theory were really valid, by a series of experiments on the descent of ice down inclined planes. The experiments were made in the following manner: a slab of sandstone, prepared to be laid down as a part of a common flagstone pavement, was so arranged as to be easily placed at any proposed inclination to the horizon. The surface of the slab, so far from being polished, retained the grooved marks of the instrument with which the quarry-man had shaped it. A quantity of ice was placed on the slab, within a frame nearly a foot square, intended merely to keep the ice together, and not touching the slab, with which the ice alone was in contact. The following were results obtained in one set of experiments, the ice being loaded with a weight of about 150lb.:—

Inclination of the planes	3°	6°	9°	12°	15°
	inches				
Mean space for one hour	0·31	·62	·96	2·	2·5

When the weight was increased, the rate of motion was also increased. The least inclination at which sensible motion would take place, was not determined; but it was ascertained that it could not exceed *half a degree* in the case of a smooth but unpolished surface. With a *polished* surface of a marble slab, the motion of the ice indicated a deviation from horizontality with as much sensibility as water itself. It will be observed, in the results above given, that (1) the motion was unaccelerated; and (2) it increased with the inclination, and (when the inclination was not greater than nine or ten degrees) in nearly the same ratio; and (3) the rate of movement was of the same order of magnitude as in actual glacial motion, which may be stated generally, in cases yet observed, never to exceed two feet a day. The extremely small friction between the plane and the ice, indicated by the small inclination necessary to produce motion, was manifestly due to the circumstance of the lower surface of the ice being in a state of gradual disintegration, which however, was extremely slow, as proved by the small quantity of water proceeding from it. In the application, therefore, of these results to the case of actual glaciers, it was necessary to show that the temperature of their lower surfaces could not generally be less than 32° Fahr. Such, the author stated must necessarily be the case, unless the conductive power of ice was greater than it was deemed possible that it could be. He considered the subglacial currents as powerful agents in the disintegration of the lower surfaces of glaciers, especially near their lower extremities. The results of Prof. Forbe's observations ou the motion of the Mer de Glace of Mont Blanc, afforded, as regards that glacier (and, by inference, as regards all other glaciers) a complete refutation of the theories which attribute glacial movements to any expansion or dilation of the ice. The Professor had, however, put forth a new theory, which agreed with that offered by Mr. Hopkins in attributing glacial motion to the action of gravity, but differed from it entirely as a mechanical theory, in other respects. The Professor appeared to reject the sliding theory of De Saussure, on account of the difficulties already mentioned (which were now removed by the above experiments), and assigned to the mass of a glacier the property of *plasticity*, or *semi-fluidity*, in a degree sufficient to account for the fact of its descending down surfaces of such small inclination. According to this theory, the motion was due to the small cohesion of one particle of glacial ice to another. Mr. Hopkins stated his conviction that the internal cohesion of the mass was immensely greater than its cohesion to the surface on which it rests, whenever the lower surface is in a state of disintegration. It was perfectly consistent with this conclusion to assign to the glacier whatever degree of *plasticity* might be necessary to account for the relative motions of its central and longitudinal portions under the enormous pressure to which, according to his theory, he showed it might be subjected. Such relative motions, however, were probably facilitated more by the *dislocation* than the plasticity of the mass. Sufficient, he trusted, had been advanced to prove that the *sliding theory* assigned a cause adequate to the production of all the observed phenomena of glacial movements. With respect to the transport of erratic blocks and detritus from the Alps to the Jura, Mr. Hopkins observed that the greatest height which glaciers had formerly attained in the valley of the Rhone (whence a large portion of the erratics had been derived), appeared to be well defined by lateral moraines and polished rocks, while the greatest height at which these blocks had been deposited on the Jura was also well defined. Thus, according to M. Charpentier, the Rhone glacier must have risen, at the mouth of the valley, to about 2,500 feet above the existing surface of the Lake of Geneva; while the highest band of detritus on the Jura was stated to rise to a still higher level. It was inconceivable, therefore, that such detritus should have been lodged at its present elevation by former glaciers. The only way in which it appeared possible to obviate the mechanical difficulties of the subject, was to suppose the transport to have been effected when the Jura was at a lower level relatively to the Alps, and the whole district lower relatively to the surface of the ocean. In such case, the space between the Alps and the Jura may have been occupied by the sea, and the ice, with its transported materials, may have passed from the former to the latter chain, partly with the character of a glacier, and partly with that of an iceberg. This hypothesis is perfectly consistent with the supposition of the general configuration of the surface of the Jura having been the same at the epoch of the transport as at the present time; and Mr. Hopkins believed it would be found equally so with all the observed phenomena of that region.

On the Granite and other Volcanic Rocks of Lundy Island, by the Rev. D. Williams, F.G.S.

Mr. Williams described this island as a mass of grey granite, three miles long by about half a mile wide, flanked at its S.E. angle by slate rocks, which beyond the immediate influence of the granite, had an E. and W. strike, and extended for about half a mile. The circumstances attending the granite were altogether unlike those of any granite mass of Devon or Cornwall. The usually abundant evidences of the processes by which the bounding rocks had been reduced and converted into granite in the vast volcanic laboratories, were all absent. He could not discover a vestige of a granite vein, nor could he observe any where a trace of gneis, mica, or chiastolite slate. In Devon and Cornwall, he had often observed that the mineral characters of granite, especially in the veins, varied with the lithological constitution of the sedimentary or other rocks, out of which it had been derived, and with which it was so intimately associated. Besides, the incorporation, the welding, as it were, of the granite in veins with the sedimentary rock, was commonly so perfect that it was altogether impossible to separate them. Now at Lundy Island, although he had repeatedly tried at several visits, he never had succeeded in detaching a specimen of slate united with either the granite, trap, or porphyry, though it was considerably indurated and altered by them, and otherwise in precisely the same condition as the slates in Cornwall. He proposed, in reference to the agency of heat on rocks contiguous to igneous masses, to distinguish between *active* and *inert* heat—the former exerted in reducing the minerals to fluids, the latter simply indurating and otherwise partially altering them. The junctions of the slate and granite at Lundy, which were very clearly exposed on the N.E. and the S.W. evidenced nothing more than the operation of inert heat: the granite there was manifestly older than the slates; the slates were older than the traps; and the traps which traversed slate and granite were older than the porphyries, which cut off and shifted the traps.

On the Discovery of the Remains of Fish, and other Fossils in the Killas of Cornwall, by MR. C. W. PEACH.

These remains were discovered in the slaty rocks ranging E. and W. of Palperro: they occured in tolerable plenty, though usually in a fragmentary condition. The most marked specimens appear to be fragments of the bony plates of Cephalaspis, the spine of Onchus, and the dermal covering, or shagreen, of the Sphagodes. The author also stated that he possesed a larger specimen, containing apparently the scales of a ganoid fish. At Goran he found a conglomerate in which are large rolled masses of limestone, with orthoceratites, crinoidea, and corals; and at Great Peraver there is a quartz rock, full of organic markings, resembling the tribes of the recent Sabellaria of the coast.

Mr. Murchison observed that this discovery confirmed, in a very remarkable manner, the view which Mr. Sedgwick and himself had taken of the age of these rocks. Those fish remains appear to belong to the Upper Silurian, the oldest rocks in which the remains of any vertebrated animals have been discovered, and they occur in rocks forming the axis of S. Devon, which he had always considered the oldest in that country.

Mr. Phillips stated, that the earliest discovery of remains of fishes in the slate rocks of Cornwall was announced in Sir H. De la Beche's Report; and he had himself figured in his 'Palæozic Fossils' the scale of a holoptychius, found in rocks lower than the Plymouth limestone, agreeing, however, more nearly with a species from the carboniferous series than with that of the old red sandstone. Mr. Phillips regarded the fish remains discovered by Mr. Peach as equally related to the carboniferous and Silurian forms, and probably belonging to an intermediate position, on a parallel with the cornstones of Herefordshire.

On some Beds of Limestone in the Valley of Cork, by C. Y. HAINES, M.D.

This outlying portion of the carboniferous system is described as consisting of three thin beds of ferruginous limestone, interstratified with carboniferous slate and yellow sandstone, forming part of a series underlying the limestone of the Cork valley; it is situate at Riverstown, and crops out at the summit of an anticlinal elevation; the limestone and slate contain Encrinites, Turbinoliæ, Spirifers, &c. Dr. Haines also exhibited some rare and undescribed fossils from the Cork limestone, and a slab of millstone grit from Kilrush, County Clare, containing some new and extraordinary impressions, apparently of a marine Annelid, slightly resembling a species of Myrianites figured in Mr. Murchison's Silurian system, and occurring in the Cambrian slates.

On the Old Red Sandstone, or Devonian, and the Silurian Districts of Ireland, by R. GRIFFITH, *Esq.*

The author stated that he should consider these two systems together, on account of the difficulty of separating the Silurian strata, which were characterized by fossils, from the Devonian, which in Ireland were only known by position and mineral character. The most northern district coloured as old red sandstone on Mr. Griffith's map, extends from Enniskillen, in the county of Fermanagh, to Pomeroy, in the county of Tyrone; and from Lisbellaw to Lisnarick, in the county of Fermanagh, occupying an area of about 300 square miles. To the north and north-west it is bounded by granite and metamorphic rocks, and to the east, south, and south-west by the carboniferous strata of Tyrone and Fermanagh. The lower beds of the latter series are usually unconformable to the brownish red sandstone and conglomerate of the system beneath. The second district of red sandstone described by Mr. Griffith forms a narrow ridge, known as the Curlew Mountains, and extends from Drumshambo, at the foot of Lough Allen, County Leitrim, in a western direction, by Moygara to Mullaghanoe Hill, in the county of Sligo, a distance of thirty-two miles, the breadth of the district being seldom more than three miles, and the greatest elevation 863 feet. The strata consist of a reddish-brown sandstone, covered unconformably by carboniferous rocks, and alternating with shale, and conglomerate which is occasionally trappean. North of Ballaghdeneen, County Mayo, there is a considerable tract of metamorphic conglomerate, passing sometimes into semi-porphyry, and at other localities becoming schistose, and passing into compact brown shale. In the midst of the metamorphic porphyry at Egool, immediately to the south of the Mountain of Mullaghanoe, is a series of rocks composed of alternations of brownish red sandstone and shale, greenish grey quartzite and slate, and impure limestone. Out of nineteen species from this limestone which occur in England, three belong to the Caradoc sandstone, three are common to the Caradoc and Wenlock formations, and sixteen to the Wenlock and Upper Silurian. Another district of the red sandstone and conglomerate is situated to the north of Castlebar, and occupies the same geological position in regard to the carboniferous series, as those already mentioned, but as yet no fossiliferous beds have been discovered within its limits. At Kildare the author had discovered thirty-two species of fossils in a mass of limestone: of these, eighteen are described in Mr. Murchison's Silurian system, all of which occur in the Caradoc sandstone, five of them, however, being common to the Wenlock and upper rocks.

On the Important Additions recently made to the Fossil Contents of the Tertiary Basin of the Middle Rhine, by R. I. MURCHISON, *Esq.*

After a sketch of the geographical limits and geological relations of the tertiary deposits which occupy the Valley of the Rhine and Mayne, around the towns of Mayence, Frankfort, and Darmstadt, Mr. Murchison gave an account of the recent discoveries made by M. H. von Meyer, M. Kaup, of Darmstadt, and M. Bronn, of Heidelberg. Of the animals of this tertiary basin

M. von Meyer had catalogued and was preparing for publication, sixty-eight mammifers, thirty reptiles, thirteen birds, and eight batrachians—nearly all being undescribed species, and most of them of small dimensions. Amongst the new animals discovered by M. Kaup, were mentioned the Chalicotherium, a genus allied to Anoplotherium and Lophiodon; the Hippotherium, differing from the recent Equus in the possession of an additional metacarpal bone, and a minute saurian, named *Pisodon Colei.* M. Kaup had determined from an examination of the remains of various species of rhinoceros, tapir, &c. occurring in this deposit, that the Fauna of the period presented a close affinity to the types of the Indian and Sumatran archipelago, and were entirely distinct from all known European mammalia. He had also collected a large series of mastodontoid remains, which completely proved the views of Prof. Owen, respecting the identity of the American Tetracaulodon with the true Mastodon. The invertebrata of the deposit have been examined by M. Alexander Braun, and have been found to comprise 450 species, 303 of which are mollusca, and 103 shells,—of which, ten species only were identical with living forms. Many of the shells approach closely in form to those in the Calcaire Grossier of Paris, and this circumstance together with the occurrence of the Anthracotherium, and of an animal intermediate between the Anoplotherium and Palæotherium, makes it probable that the deposit belongs to the same age as the gypsum beds of Montmatre, and the Ryde and Binsted strata of the Isle of Wight. These tertiary beds are covered with gravel, sand, and löss, containing ninety-six species of shells, fifty-six of which are terrestrial, and forty fluviatile. Of these, seven belong to species now living, and nine others are probably varieties of existing species—the most abundant species are very rare in a living state, whilst those now common are of unfrequent occurrence in the löss. With the shells are associated the remains of mammoth, rhinoceros, tichorinus, &c., the bones of which have evidently received very little injury from diluvial action; and from the frequent occurrence of entire skeletons, Mr. Murchison infers that these superficial deposits were formed by very tranquil operations, and that the great mammalia inhabited tracts immediately adjacent to the spots where they are now entombed.

MISCELLANEA.

Section of strata passed through in sinking an Artesian well at the tape works of Messrs. Milne & Co. Woodman Hill, (near Aberdeen.)

	feet.	
Vegetable mould	6	
Gray or bluish clay	18	
Sand and shingles enclosing rolled stones of various sizes	20	
Rough sand and shingle	3	
Old red sandstone conglomerate, composed of red clay, quartz, mica, and rolled stones	115	
Alternating strata of compact fine grained red sandstone from one foot to seven feet; and clay varying from six inches to twelve feet thick	74	
Light blue clay	6	
Mica slate formation	8	9
	250	9

The temperature of the water at the bottom of the well was found to be within a fraction of 50° Fahr. whilst the average temperature of the localities deduced from twenty three years observation by the late Geo. Innes, F.R.S. is 47° 1′, hence nearly 3° of increase appear as the effect of central heat. The supply of water is excellent.

REVIEWS.

New Geological maps of Great Britain and Ireland.

We purpose making a few remarks, under the above title, on two new maps relating to the geology of Great Britain, totally dissimilar however in every other particular. *Knipe's Geological map* includes the British Isles, and is of a large size and most elaborate detail, the style of colouring is clear, and the mineral deposits are well distinguished, and the whole being on one sheet, the continuity and contiguity of strata are well and clearly distinguishable. This map contains many of the excellencies of former publications—it is not large enough to be cumbersome, nor is it too large for the library wall, and from the inspection which we have carefully made we should say that it is decidedly a very correct performance, and worthy of an exalted rank in the series of geologico-geographical charts.

The second is a small map *in relievo* of England and Wales, published by Messrs. Dobbs & Co ; the idea is good, and, so far as it goes, is well carried out—of the colouring, too, we cannot speak too highly—but the scale is too small to convey any of the accuracy which is requisite for the purposes of science, and hence its principal utility will be confined to the same limits as other geological charts of the same size; but to those who wish to posess a map, giving only the general features of the geology of England and Wales, and for beautifying the walls of their libraries, this map will answer every purpose, and it is very mode-in price.

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1. *Practical Mineralogy, or Compendium of the distinguishing characters of Minerals, by* EDWARD J. CHAPMAN, 8vo. *plates.*

2. *An Introduction to Mineralogy, being the natural system of Classification of Mineral and Metallic bodies, by* CHARLES MOXON, small 8vo. London, H. Baillière, 1843.

The above works having only come to hand at the eleventh hour, must, for the present, be passed over with a few brief reremarks on their respective plans. The former is an exceedingly elaborate manual, not of *simple* mineralogy, but including the examination of minerals before the blow-pipe, as the means of identifying their respective qualities; in other words, to establish a simple method by which the nature of any mineral substance may be determined. A new "classification" is appended, but as this requires a more minute consideration, it must be passed over for the time. The work is a *very* creditable performance. The aim of the second work is not so high—it is designed as a cheap and concise manual of chemical mineralogy and also introduces a new system of classification—we should say *entirely new*, as it is dissimilar from any yet published, whilst the former work is based upon similar systems already in use, to a certain extent—the two works, then, are entirely dissimilar—the former is in the rank of "high science," whilst the second, from its style and cheapness, may be classed with "popular science."

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Smith and Titford, Printers, 10, King Street, Snow Hill.